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The PROGRESSIVE FISH-CULTURIST

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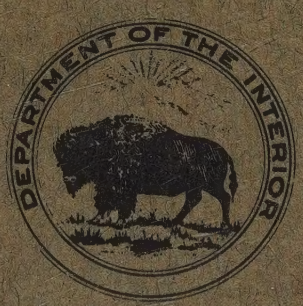

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FISH AND WILDLIFE SERVICE

PROGRESSIVE FISH-CULTURIST

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(See inside back cover)

The PROGRESSIVE FISH-CULTURIST

News and Views from many Sources on Practical Hatchery Problems

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PROPHYLACTIC TREATMENT FOR CONTROL OF FUNGUS (*SAPROLEGNIA PARASITICA*) ON SALMON EGGS

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UNCONTROLLED fungus growths have presented a serious problem in the artificial propagation of the eggs of salmon and trout. Fungus (Saprolegnia parasitica), if allowed to grow unchecked on the dead eggs, will develop a luxuriant growth which spreads from the dead eggs to adjacent living eggs. A living egg, if included in the mass of fungus, is smothered or, if not completely surrounded, may survive but with the shell so weakened by the fungus that a premature hatch occurs and the fish dies. This problem is met usually in one of two ways: first, removal of the dead eggs before fungus has a chance to develop excessive growth; or second, retention of the eggs undisturbed until the eye spots are well developed and the eggs may be handled safely. Removal of the dead eggs usually results in an increased mortality because the fungus development and the sensitivity of the eggs to shock progress concurrently. The second procedure, the retention of all the eggs through the critical period, may result in a reduced mortality if the number of dead eggs is small and the rate of development is rapid or if effective fungus-control measures are employed throughout the incubation period.

Investigators have developed various methods and disinfectants for the control of fungus on eggs. Watanabe (1940) used formalin administered as a half-hour dip. Foster and Woodbury (1936) and O'Donnell (1947) used malachite green either as a dip or as a flush. Schneberger (1941) and O'Donnell (1947) used copper sulphate as a flush. Though all these disinfectants have been reported as effective fungicidal agents, the results have been erratic and could not always be repeated because of the methods of treatment employed.

A series of experiments was conducted between 1943 and 1946 at the Leavenworth Laboratory of the Fish and Wildlife Service to develop a satisfactory method of treatment and effective fungicidal disinfectants for the control of fungus on salmon eggs. The most satisfactory treatment was the constant-flow siphon method, in which the eggs were given a 1-hour exposure to a disinfectant at semiweekly intervals throughout the early stages of development. In this method of application, either malachite green at a 1:200,000 concentration or formalin at a 1:1,000 concentration was effective as a fungicide.

DEVELOPMENT OF METHOD

Two methods, the flush and the dip, have been used for the control of fungus on eggs. In the flush treatment, a measured amount of a stock solution of the disinfectant is poured into the first compartment of the trough. This solution is distributed in the flow of water by dilution and diffusion. In the dip technique, the eggs are removed from the trough, allowed to drain, and then submerged in a known concentration of the disinfectant.

Certain disadvantages were apparent when these methods were evaluated. It was found that flushes at semiweekly intervals with malachite green (even at four times the concentration recommended by O'Donnell) would not control fungus on dead eggs. Eggs in the first stack of trays at the head of the trough were exposed to a heavy concentration of the disinfectant for approximately 20 minutes, and those in the last stack received a relatively light concentration for 60 minutes. The prolonged dip method was applicable only when the eggs were held in containers, such as baskets, which could be moved and drained readily. The required handling shocked a portion of the eggs and caused an increase in mortality. The procedure was slow and tedious as well as costly. Neither method appeared to be a practical hatchery procedure.

Evaluations of the recommended methods of treatment established certain criteria for a practical treatment: (1) it should be applied without disturbing the eggs, (2) it should be uniform in its distribution, and (3) it should be of a known concentration. A prolonged dip introduced by a constant-flow siphon method satisfied all these requirements. This method incorporated all the advantages of both dips and flushes and eliminated the disadvantages.

The constant-flow siphon method was not adaptable to the small-scale experiments necessary for the evaluation of various disinfectants and the determination of a technique. The prolonged dip, therefore, was used in the preliminary experimentation. These experiments were designed to ascertain for various disinfectants the most practical exposure period for the control of fungus, the maximum concentration which the eggs would tolerate, and the minimum concentration which would control fungus.

The disinfectants selected for test because of their known fungicidal qualities, were alkyl di-methyl benzyl ammonium chloride (Roccal), di-isobutyl phenoxy ethoxy di-methyl benzyl ammonium chloride (Hyamine 1622), malachite green (containing a minimum of zinc), and formalin. Copper sulphate was not used because of its variability in toxicity and efficacy in waters of different calcium content.

The preliminary experiments to develop the technique and determine the toxicity and efficacy of the disinfectants, were made with eggs of steelhead trout (Salmo gairdnerii). The final evaluations of the method developed were made with eggs of blueback salmon (Oncorhynchus nerka).

In the development of the technique, a 1-hour exposure period was the most practicable. A shorter exposure period (30 minutes) increased the concentration required for effective control and decreased the margin between the effective and toxic levels of the disinfectant. A longer exposure period would not be readily applicable to routine hatchery procedure. In the final determinations, all the disinfectants tested were evaluated for a 1-hour exposure period.

The toxicity tests were conducted on lots of five eggs each. The eggs for all test lots, including the control, were taken from a single female. After the toxic levels had been ascertained, they were confirmed by use of 30 eggs in each test lot and the controls. Treatments were continued at semiweekly intervals for a 30-day period.

A comparable technique was used to determine the efficacy of each disinfectant for the control of fungus, but 1-day-old, fungus-free, dead eggs were used in these trials. The criterion in these tests was the development of an excessive fungus growth: if the fungus developed between treatments to such an extent as to bind one egg to another, the concentration level was not considered effective; if a slight growth developed but the eggs remained separate, the minimum control level had been ascertained.

Listed in table 1 are the greatest concentrations at which the eggs would tolerate 1-hour exposure to the various disinfectants without mortality and the effective levels for the control of fungus with those disinfectants.

Of the four disinfectants tested, only formalin and malachite green were effective fungicides at concentrations tolerated by the eggs. Of these, malachite green showed the greatest margin of safety as indicated by the difference between the survival and fungus-control concentrations.

TABLE 1.--Survival and fungus-control concentrations of disinfectants used in a 1-hour exposure period

Disinfectant	Survival level: Single treatment	Survival level: Semiweekly treatments	Fungus-control level
Malachite green	1:10,000	1:100,000	1:300,000
Formalin	1:200	1:500	1:1,000
Roccal	1:30,000	1:200,000	Below 1:200,000
Hyamine 1622	1:50,000	1:200,000	Below 1:200,000

To provide an adequate margin of safety, the concentrations of malachite green and formalin (table 1) were diluted to levels equal to half of their original potency. Malachite green at a 1:200,000 concentration provides an adequate safety factor and is still well below the minimum fungicidal level, while formalin at the 1:1,000 concentration (the required safety level) is at the minimum effective concentration. These two concentrations were selected for application by the constant-flow siphon technique, at semiweekly intervals, to test the method as a practical hatchery procedure.

The experiment involved three lots of blueback eggs selected at random from the collections of a single day. Each lot contained 108,000 eggs. The first lot, serving as a control, received the customary hatchery treatment: the dead eggs were removed within the first 24 hours after collection, and the remainder were left undisturbed until an advanced eyed stage was reached. The second and third lots received semiweekly treatments with malachite green and formalin. In these experimental lots, no dead eggs were removed until the final pick-off just prior to hatching was made in all three groups.

The results indicated that between the control and the treated lots there was no difference in mortality. Although fungus did develop in the controls and did not develop in the treated groups, the number of infertile eggs in the control group (2 percent) was so small and the dead eggs were so isolated that fungus growths did not develop sufficiently to increase the mortality.

A subsidiary phase of this experiment was designed to measure the distribution of the disinfectant throughout the trough. Each lot of eggs was divided among three baskets, which then contained 36,000 eggs each. The baskets were placed in the first two and the last or fifth compartment of the trough. Should an unequal distribution of the disinfectants occur, at least to a degree sufficient to exceed the toxic levels, the mortality would be high in the first compartment and progressively lower in the second and fifth compartments of the trough. The data, when treated by analysis of variance, showed no difference in mortality due to the position of the baskets in the trough.

Because of the adequate margin of safety between the minimum survival and the treatment levels, no toxicity was anticipated. There was the possibility, however, that if the concentration became too diffuse, fungus would not be controlled in the fifth or last compartment of the trough. This hypothesis was particularly applicable to the formalin treatment, in which the minimum fungicidal level was used. In no treated basket, however, did fungus develop beyond the point where the individual dead eggs presented more than a slightly fuzzy appearance, whereas among the untreated controls all dead eggs showed extensive fungus growth.

It was concluded from this experiment that either malachite green or formalin at the concentration used was an effective fungicide when administered at semiweekly intervals by the constant-flow siphon method. Of the two disinfectants, malachite green appeared to have the greatest potentialities because of its greater factor of safety and its materially lower cost per treatment. Although formalin is much cheaper per pound, the

difference in the concentrations used makes the treatment cost 40 times that of malachite green.

On the basis of these experiments, Slater (unpublished) tested the method on a much larger scale at the Coleman (California) Laboratory of the Fish and Wildlife Service. His results showed that routine semiweekly treatments with malachite green (1:200,000) adequately controlled fungus and that treatments could be administered throughout the green-egg stage of development at a cost of $0.013 per thousand eggs treated. This cost included the disinfectant used, as well as the labor required for the treatment and removal of the infertile eggs at the conclusion of the critical period. Under normal hatchery procedure, which involved no treatment beyond removal of the dead eggs at weekly intervals, the cost of fungus control amounted to $0.039 per thousand eggs. It should be noted, moreover, that the losses due to infertile eggs in the experiment amounted to but 3 percent of the lot: the lower percentage of fertilization ordinarily obtained at salmon hatcheries would greatly increase the cost of fungus control by picking the eggs, whereas the cost of treatment would not be increased by the presence of more dead eggs.

All the accumulated evidence indicates that fungus-control measures are warranted as a standard hatchery procedure if the constant-flow siphon method is used. The labor demand and cost of operations are much lower than those of normal operating procedures. The mortality caused by excessive fungus growths on dead eggs or by the removal of the dead eggs during the critical period of egg development, may be eliminated. Though either malachite green or formalin is an effective fungicidal agent, malachite green is to be preferred because of its greater tolerances and cheaper cost of application.

CONSTANT-FLOW SIPHON

The principle of the constant-flow siphon, namely, the delivery of a definite volume at a constant rate regardless of the height of the liquid in the container, was developed by Mariotte in ancient times. By the insertion of an open tube in addition to the siphon tube, atmospheric pressure in a sealed container is maintained at the depth of the open tube; hence the siphon will deliver at a constant rate at all times. Mariotte's bottle is the simplest and most practical of the many contrivances designed to secure a constant flow from a siphon.

The assembly of the constant-flow siphon (see figure) is a relatively simple procedure. Any 1-gallon jug or bottle that can be fitted with a rubber stopper will serve as a container. A three-hole rubber stopper that tightly closes the mouth of the bottle is fitted with one open glass tube which extends from above the rubber stopper to within 3/4 of an inch of the bottom of the bottle. A second glass tube, also inserted in the stopper and bent as illustrated in the figure, extends to within 1/2 inch of the bottom. The third hole is stoppered with a solid glass rod. The glass tubing of the siphon should be 1/8 inch inside diameter. To the outer end of the siphon tube, a rubber tube of 3/16-inch inside diameter is attached. This tube should be of sufficient length to extend about 4 inches below the bottom of the bottle. At the lower end of the rubber tube, a 2-inch length of 1-milliliter diameter capillary tubing is inserted.

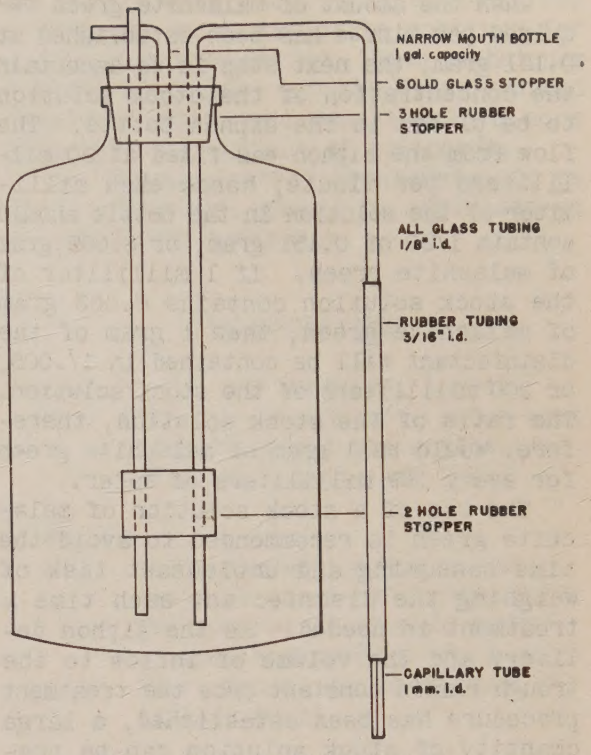
Certain precautions are necessary to insure a consistent delivery from the siphon. Once the siphon bottle has been assembled, the stopper should not be removed, as it is almost impossible to replace the siphon in exactly the same position and any change in position changes the head with a resultant change in the delivery rate. When it is necessary to replenish the liquid in the bottle, the glass stopper is removed and the disinfectant introduced through the open tube. Air bubbles will enter the siphon tube and block the flow unless the bottom of the open tube is placed 1/4 inch higher than that of the siphon tube and a spacer is positioned toward the bottom of the tubes to prevent their overlapping when the stopper is inserted into the bottle mouth. The spacer is made from a two-hole rubber stopper with a diameter such as to allow it free entry into the mouth of the bottle.

The adjustment of the delivery rate of the siphon to 30 milliliters per minute, the most satisfactory flow, is made by variations in the head or the vertical difference between the lower end of the open tube in the bottle and the lower end of the capillary tube. A difference of 5 to 6 inches will deliver the desired flow. The allowances for overlap in the rubber and glass tubes make possible an increase or decrease in head as desired. It is imperative that the determination of the delivery rate be made with the concentration of the disinfectant to be used. Water cannot be substituted, as formalin is more viscous than water and flows at a slower rate, while malachite green, in solution, is less viscous and flows at a faster rate. After the final adjustments have been made, all joints should be sealed with a waterproof cement.

In actual operation, it has been found highly desirable to maintain fluid within the siphon tube between treatments. Either a small pinch clamp placed on the rubber tube, or a cap (made from a short piece of rubber tube and a glass rod) placed over the end of the capillary tube, will prevent the loss of the siphon.

A wooden carrier will prove valuable to protect the bottle and the glass siphon tube from breakage. The carrier also serves as a level base for the siphon at the head of the trough.

The constant-flow siphon is a relatively simple piece of apparatus to assemble. Although all the required components may not be available around the fish hatchery, they may be secured from any scientific-supply house. Once assembled, the siphon needs no further adjustment and, if properly handled, will give years of service.



The constant-flow siphon.

TREATMENT TECHNIQUE

The constant-flow siphon method of treatment relies upon the inflowing water to carry the disinfectant and distribute it evenly throughout the trough. The concentration of the treatment, therefore, is dependent on the volume of water inflow and the concentration and rate of discharge of the disinfectant.

The amount of inflowing water per minute must be determined with reasonable accuracy to establish the amount of disinfectant required for a desired concentration. With the volume of inflow known, the amount of disinfectant required for treatment may be calculated. For example, if the water inflow has been measured at 8 gallons per minute and it is desired to treat with malachite green at a 1:200,000 concentration, the computation would be made in this manner:

1. The inflow should be converted from gallons to milliliters per minute: 3,785 (the number of milliliters per gallon) multiplied by 8 (the inflow in gallons per minute) equals 30,280 milliliters per minute, the rate of water inflow.

2. A proportion then is set up to determine the amount of malachite green required for the treatment as follows: 1:200,000 equals x:30,280, i.e., x equals 30,280 times 1 divided by 200,000--or 0.151 gram of malachite green required per minute.

When the amount of malachite green required per minute has been established at 0.151 gram, the next step is to ascertain the concentration of the stock solution to be placed in the siphon bottle. The flow from the siphon was fixed at 30 milliliters per minute; hence each milliliter of the solution in the bottle should contain 1/30 of 0.151 gram, or 0.005 gram of malachite green. If 1 milliliter of the stock solution contains 0.005 gram of malachite green, then 1 gram of the disinfectant will be contained in 1/.005, or 200 milliliters of the stock solution. The ratio of the stock solution, therefore, would be 1 gram of malachite green for every 199 milliliters of water.

The use of a stock solution of malachite green is recommended to avoid the time-consuming and unpleasant task of weighing the disinfectant each time a treatment is needed. As the siphon delivery and the volume of inflow to the trough remain constant once the treatment procedure has been established, a large quantity of stock solution can be prepared and transferred directly to the siphon bottle at the time of treatment.

Variations in the water inflow or in the rate of discharge from the siphon will alter the strength of the stock solution, but the method of calculation is the same. The strength of the stock solution, however, should not exceed 1 part malachite green to 150 parts water; otherwise, there is danger of creating a supersaturated solution from which crystals of the disinfectant will precipitate. To meet this requirement, the water inflow should not be more than 8 gallons per minute nor the discharge rate from the siphon less than 30 milliliters per minute.

The stock solution can be prepared in large quantities and stored in a carboy for use as required. To facilitate the filling of the constant-siphon dispensers, the large carboy is equipped with a siphon hose and the solution is siphoned into the dispensers as required.

With all preparations complete, the treatment is ready for application. Two techniques for the administration of the treatment are available, depending upon the quality of the fish-cultural equipment. In either procedure, the siphon is placed so that it discharges into the head compartment of the trough as near as possible to the point of water inflow. If the troughs and dam boards are tight enough to hold water over the eggs for a 1/2-hour interval of water shut-off, the siphon is allowed to discharge into the trough for a 30-minute period. Next, both the water inflow and the siphon are stopped and the solution is allowed to remain in the trough for an additional 30 minutes. The water inflow is then resumed at the same rate as during the introduction of the disinfectant, and the solution is allowed to clear itself from the trough by replacement. In this manner the eggs in all portions of the trough are given a full hour of exposure to the disinfectant with but half the solution required. Likewise, the dispenser is freed for additional treatments after a 30-minute interval. If the hatchery equipment is not tight and the water drains from the eggs during a 30-minute period of water shut-off, then the solution must be introduced for the full hour period. Either method produces satisfactory results, but the advantages of the first technique are quite obvious.

Treatments, by either method, should be repeated at semiweekly intervals to prevent the development of fungus on the dead eggs. The routine of treatment should start within the first week after the eggs are brought into the hatchery and should continue until an advanced eyed stage is reached. This procedure eliminates the necessity for an initial pick-off or for any intermediate removals of dead eggs.

SUMMARY

The results of this experimentation may be summarized as follows:

1. Preliminary experiments indicated that neither dips nor flushes proved practicable for the control of fungus on salmon eggs.

2. The constant-flow siphon method was found to meet all the requirements of an adequate fungus-control method: (a) it could be applied without disturbing

the eggs, (b) it was uniform in its distribution, and (c) it could be administered in a known concentration.

3. Of the disinfectants tested, formalin and malachite green proved to be effective fungicides at concentrations which were tolerated by the eggs.

4. Malachite green is recommended at 1:200,000 concentration for a 1-hour exposure period, as being the most practicable of the two fungicides because of its lower treatment cost and its wider tolerances.

5. Large-scale experiments conducted by Slater indicated that fungus-control measures are more economical than the usual weekly removal of dead eggs.

6. The constant-flow siphon, an adaptation of Mariotte's bottle, can be assembled easily and is readily applicable to hatchery techniques.

7. Two treatment techniques were developed, depending upon the quality of the fish-cultural equipment available. The first allowed the siphon and inflowing water to run for the first 30 minutes of the treatment, after which both siphon and water inflow were shut off for an additional 30-minute period; then the water inflow was resumed at the original treatment rate and the solution was allowed to clear. The second, necessitated when faulty equipment would not maintain the water level over the eggs for a 30-minute period of water shut-off, allowed the siphon and water inflow to continue for a full 60-minute period. Both techniques controlled fungus, but the first reduced treatment costs and resulted in a more efficient utilization of equipment.

8. Fungus-control treatments, to be fully effective, should be administered at semiweekly intervals.

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Before the turn of the century, transportation of oysters to distant points was exceedingly difficult: too many oysters opened before they reached their market. A resourceful shipper in Philadelphia undertook to "wire" his oysters, placing a rather stout wire tightly around the valves. A stock company, holding letters patent on the process, was formed for the express purpose of wiring oysters for shipment alive in the shell. At first, all the work was done with pliers and was necessarily slow. In November 1890, special machines speeded up the work so that one man set a record of 48 oysters wired in one minute--though the average was much less. Apparently oysters that had been wired for as long as 60 days showed no deterioration of quality or flavor.

THOSE NEW IDEAS

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Albin Anderson, Minnesota fish-culturist, has been browsing in second-hand book stores recently and has come up with evidence that some of the "new" ideas in fish culture aren't so new after all. He brought in the 1853 and 1857 volumes of the American Institute of the City of New York, volumes which contain observations on fish culture by Robert J. Pell, of Pelham, New York, and abstracts of then current European fishery work.

Mr. Pell's numerous papers indicate that he was a gentleman farmer of some standing, considerable education, and unlimited curiosity. He was president of the American Institute in 1857 and wrote on such diverse subjects as city drainage, horseshoeing, photography, and light. His main hobby, however, seems to have been fish culture.

He began raising fish in the eight artificial spring-fed ponds on his farm about 1840. He states that in these ponds he had reared 45 varieties of fish. He was not satisfied, however, with rearing them but made many observations on spawning habits, anatomy, artificial propagation, and behavior of fish. He investigated the senses of sight and smell in fishes and made many observations on the habits of eels.

He was especially interested in "fresh-waterizing" salt- and brackish-water fish, and he succeeded in raising shad, sturgeon, and striped bass in his ponds but failed with herring, cod, and haddock. In his ponds he had pike, trout, perch, sunfish, rock bass, "black bass," and several other fresh-water species.

In 1857, he also had carp "in great numbers" reared from stock obtained from a Captain Robinson of Newburgh. He calls his carp "Cyprinus carpio," and as he was familiar with this fish in Europe, there seems to be little doubt but that he was about 20 years ahead of the U. S. Fish Commission in rearing carp. Pell fed his carp bread and Indian meal, trained them to come to the sound of a bell, crossed them with goldfish, and noted that they were nearly dormant in winter.

Pell's papers on fish are a curious mixture of shrewd observations, Waltonian folklore, wrong conclusions, and statements that have a strikingly modern ring. For example, in one breath he notes that salmon cannot be taken by a fisherman in a red cap or coat, and in the next breath he states that "the age of fish is indicated by the concentric rings on the scale, if scale fish; if smooth by rings in the vertebrae of the back bone."

In the 1857 volume (page 288) is a summary of a salmon marking and recovery experiment conducted on the River Tay in England in the 1830's, an experiment that would reflect credit on any present-day fishery investigator. Also, in the 1853 volume (page 459), there is the observation that a Mr. Tull "had fish ponds so full of fish, that they had not room to grow to a desired size." Mr. Tull's solution to this overcrowding problem was entirely his own. "He castrated them, both male and female" and found that they grew much larger and were always in season for the table. Unfortunately, no explanation is given as to how this neat surgical trick was accomplished.

CONTROL OF PONDWEEDS WITH 2,4-D

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THE TEDIOUS job of keeping the edges and shallow-water areas of farm fishponds free of emergent weeds, such as cattail, bulrush, needlerush, and arrowhead, takes time which might be better spent in fishing the pond.

Failure to keep these weeds under control reduces the use and enjoyment of the pond. By giving small fish protection from the larger ones, weeds cause an increased percent of the fish poundage to consist of stunted fish, too little to catch. The marginal vegetation provides a haven for the breeding of mosquitoes and a refuge for snakes. Fouling plugs and hanging hooks, weeds are also a source of irritation to the fisherman.

In the past, pulling the weeds by hand or cutting with a scythe or hoe several times during the growing season, has been the most effective method of control. Though effective, these methods are time-consuming and expensive where labor must be hired. Development of a weed-killing compound called 2,4-D (2,4 dichlorophenoxyacetic acid) gives pond owners a means of controlling susceptible species of emergent pondweeds at a considerable saving in both time and money. This compound, when applied as a spray to weeds, causes their death in 1 to 4 weeks, depending upon the susceptibility of the plant.

In general, the broad-leaved, succulent type of weed is most susceptible to the killing action of 2,4-D, whereas the grasses are rather resistant. In experiments conducted over a 2-year period at the Alabama Agricultural Experiment Station (Auburn), arrowhead, bulrush, cattail, knotgrass, and needlerush were effectively controlled with 2,4-D when the proper concentration of spray was applied. Parrotfeather, primrose-willow, and waterlily were susceptible to the killing action of 2,4-D; but as these weeds normally grew partly submerged in the pond, the roots and submerged stems usually survived treatment, later putting out new growth to replace that killed by the 2,4-D. Growth of these latter species can be largely controlled, however, by making several applications of the spray during the growing season. Species of weeds that may be controlled, along with the most effective treatment, are listed in table 1.

The materials and equipment necessary for treating weeds with 2,4-D sprays are not difficult to obtain. For small ponds of 1 to 3 acres in size or for larger ponds that have only a limited area occupied by vegetation, the spray can be

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1947. Control of aquatic plants with phenoxyacetic compounds. Prog. Fish-Cult. 9 (3): 143-150.

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1948. Cattail control with scythe and 2,4-D. Prog. Fish-Cult. 10 (3): 153-154.

TABLE 1.--Emergent weeds which may be controlled with 2,4-D, and most effective treatment

Common name	Scientific name	Form	Concentration[1/] (percent)	Carrier	Remarks
Arrowhead	*Sagittaria* sp.	Any 2,4-D preparation	0.1	Diesel fuel or water	Highly susceptible.
Bulrush	*Juncus* sp.	Ester of 2,4-D	0.25	Diesel fuel or water	Treat before seed form; moderately susceptible.
Cattail	*Typha* sp.	Ester of 2,4-D	0.25	Diesel fuel	Several applications are needed; moderately susceptible.
Knotgrass	*Paspalum distichum*	Ester of 2,4-D	0.25	Diesel fuel	Moderately susceptible.
Needlerush	*Eleocharis* sp.	Ester of 2,4-D	0.25	Diesel fuel or water	Moderately susceptible.
		2,4-D sodium salt	0.50	Water	-
Parrotfeather	*Myriophyllum brasiliense*	Any 2,4-D preparation	0.10	Water	Several applications are necessary; highly susceptible.
Pennywort	*Hydrocotyle* sp.	Ester of 2,4-D	0.25	Diesel fuel or water	Moderately susceptible.
Primrose-willow	*Jussiaea diffusa*	Salt or ester of 2,4-D	0.10	Diesel fuel or water	Several applications are necessary; highly susceptible.
Waterlily	*Nymphaea odorata*	Salt or ester of 2,4-D	0.25	Diesel fuel or water	Several applications are necessary; moderately susceptible.

[1/] Percentages are based on the amount of active ingredient in the preparation.

applied with a knapsack-type 4- or 5-gallon sprayer. The 2,4-D may be purchased under a variety of trade names at most hardware stores. It may be obtained in a powder form (a salt of 2,4-D) or in liquid form (an ester of 2,4-D) or in some specially compounded solution that contains 2,4-D. The product of any reputable manufacturer is satisfactory, but use of the ester forms has produced the best results on weeds resistant to the killing action of 2,4-D.

In making up the spray solution, either water or oil may be used as a carrier for the ester of 2,4-D. Usually, best results may be obtained from a mixture of the ester of 2,4-D and diesel fuel or kerosene. More complete coverage of the plants, faster application, less spray solution, and less loss by run-off of the spray, are some of the advantages of using the oil mixture. The powder, or salt form of 2,4-D, costs less than the liquid form. On the more susceptible species of weeds, the salt is the more economical form to use, even though somewhat more of the spray solution is required to give effective results. Water must be used as the carrier, as salt forms will not mix directly with oils.

The strength of the spray mixture is figured on the basis of the amount of active ingredient in the 2,4-D preparation. For some of the commercial preparations available, amounts required for a 0.1-percent spray solution (1,000 p.p.m.) are given in table 2. Higher concentrations can be made by multiplying this amount by the number of times the concentration of 2,4-D is increased. For example, to make a 0.25-percent concentration, the quantity used in a 0.1-percent concentration should be multiplied by 2.5.

The 2,4-D should be thoroughly mixed with the carrier before being poured into the sprayer tank. This spray mixture or solution is then applied to the weeds at a rate sufficient to cover the major portion of the leaves and stems without appreciable loss by run-off. For most effective coverage, the material should be applied in relatively fine drops in a fan-shaped pattern. Rainfall within 12 hours after application of the water solution of 2,4-D sprays will decrease the effectiveness of the treatment. The oil mixture gives good effect even though rain falls only a few hours after application.

The first effects of the 2,4-D spray become noticeable by the second to sixth day after treatment, depending on the species of weed treated. The broad-leaved species usually take on a wilted appearance 1 day after being sprayed; later the plant becomes yellow, then brown, dying in 10 days to 2 weeks. Resistant species of weeds, such as cattail or knotgrass, do not show the effect of the

TABLE 2.--Rate of dilution for 2,4-D sprays[1/]

Compound	Active ingredient	Accurate measure units/gallon	Field measure units/gallon	Field measure units/100 gallons
	(percent)	(gram)	(level teaspoon)	(pound)
Salts of 2,4-D				
Ammonium salt	83.5	4.5	2	1.0
Sodium salt (DuPont)	83.5	5.0	2	1.1
Sodium salt (Dow)	30.0	12.5	6	2.8
		(cubic centimeter)		(quart)
Esters of 2,4-D				
Weed-No-More 40	40.0	9.6	2	1.0
Weed-No-More 14	14.0	29.7	6	3.0
Weedone	9.6	38.4	8	4.0

[1/] These dilutions give a spray solution of 0.1-percent 2,4-D, or 1,000 parts per million.

treatment so soon; they may require 4 or more weeks before dying. Complete coverage of all plants may not be obtained by using a small sprayer, especially when the weeds are growing thickly; however, spot spraying about 10 days after the original treatment will eliminate weeds that are missed.

The amount of spray material required to treat a given area adequately varies considerably and depends upon the species, density of growth, and age of the weeds. Usually, where water is used as a carrier for the 2,4-D, from 100 to 400 gallons of solution are required per acre; whereas 50 to 100 gallons are sufficient to treat an acre if diesel fuel or kerosene is the carrier.

Several precautions should be observed when 2,4-D is used for spraying emergent pondweeds. High concentrations of the ester forms or some of the derivatives of 2,4-D are toxic to pondfish, causing death in some instances. When the compound is used according to recommendations, however, this danger does not exist. After the weeds have been sprayed, the sprayer should be washed carefully with soap and water and thoroughly rinsed; this should be done immediately after using if the equipment is to be used later for applying insecticides or fungicides to garden plants, fruit trees, or field crops. It is well to spray a few plants with the wash water in the sprayer after thoroughly cleaning it, and to observe these plants for a few days for possible damage, before using the sprayer for gardens or orchards. Sprays of 2,4-D are ineffective at low temperatures, and little damage is done to the weeds when they are treated at temperatures below 50° F. For most effective results, sprays should be applied when the weeds are young and growing rapidly. In small amounts, the chemical is reported to be harmless to warm-blooded animals.

Two or more sprayings have been found necessary to kill completely most of the aquatic plants listed. This is especially true of those growing with partially submerged leaves, such as parrotfeather, and of those with large submerged rootstocks, such as the waterlilies.

N O T E

I am preparing a compilation of available information on the growth, length-weight relationships, condition, and egg counts of fresh-water fishes of North America. I would therefore appreciate receiving copies of mimeographed bulletins or other publications with limited circulation which contain data in any of the above classifications. I shall be glad to return such bulletins, where desired.

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USE OF COD-LIVER OIL IN THE DIET OF HATCHERY-REARED TROUT

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THE ADDITION of various vitamin supplements to the diets of higher animals, has produced highly beneficial effects. Cod-liver oil is widely used because of its high content of vitamins A and D. Particularly in young animals, normal, healthy growth would not be possible without the use of this product. Several workers have reported beneficial effects from the addition of cod-liver oil to the diet of trout (Davis, 1927; Gutsell, 1939). In the summer of 1948, the Cortland Laboratory used cod-liver oil as a supplement to the standard diet of this hatchery to determine the growth-promoting properties of cod-liver oil under these conditions.

Three percent of cod-liver oil was added to the standard diet given to three species of trout (brook, brown, and rainbow) held in similar troughs. These troughs of fish were then compared with similar troughs of fish fed the standard diet without the addition of the oil. The experimental fish were handled according to the established procedure of this hatchery (Tunison et al., 1939).

The experiments were run for 20 weeks, starting in mid-April and ending early in September. The fish were held in troughs supplied with water at a temperature of 47° F. All results were tested statistically by means of analysis of variance.

The composition of the diets used in these experiments has been listed in table 1, and the results have been summarized in table 2. The data have been plotted on the accompanying graphs. The graphs show the major variables of the experiment plotted against total percent gain. The various graphs readily show the basis for the conclusions drawn.

The addition of cod-liver oil resulted in an increased rate of growth for all three species of trout. The most marked effect was shown in the brook trout experiments, and the least noticeable effect appeared in the rainbow trout experiments. The rate of growth of both brown and rainbow trout is much less at the cold temperatures of these experiments; it should be expected that at warmer water temperatures a more marked effect of the oil would be noted. The use of cod-liver oil, at the level of 3 percent of the diet, would not add excessively to the cost of production when the additional

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See also:

Gutsell, J. S.
1948. Cod-liver oil in the diet of trout. Prog. Fish-Cult. 10 (2): 81-83.

Phillips, A. M., Jr., and Brockway, D. R.
1948. Vitaminology. Prog. Fish-Cult. 10 (3): 117-124.

TABLE 1.--Diet composition of cod-liver oil experiments

Trough No.	Beef spleen (percent)	Dry feed mix No. 6a[1] (percent)	Cod-liver oil (percent)
1	47.0	50.0	3.0
2	47.0	50.0	3.0
3	50.0	50.0	-
4	50.0	50.0	-
5	47.0	50.0	3.0
6	47.0	50.0	3.0
7	50.0	50.0	-
8	50.0	50.0	-
9	47.0	50.0	3.0
10	47.0	50.0	3.0
11	50.0	50.0	-
12	50.0	50.0	-

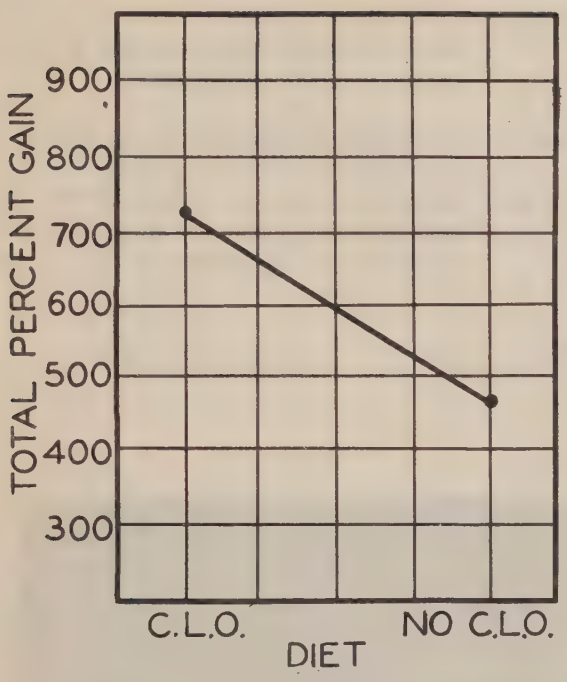
[1]/Composed of 24 parts each of cottonseed meal and wheat middlings; 48 parts of fish meal; 4 parts of salt.

gain is taken into consideration: It is not possible to say at this time whether vitamin A or D or the combinations of these two, caused the increased rate of growth. In fact, some other factors of the cod-liver oil (factors unknown at this time) might be responsible for the increased rate of growth. If vitamin A alone was responsible, beef liver itself might be a good source; if vitamin D was responsible, some sources such as cod-liver oil would be most effective.

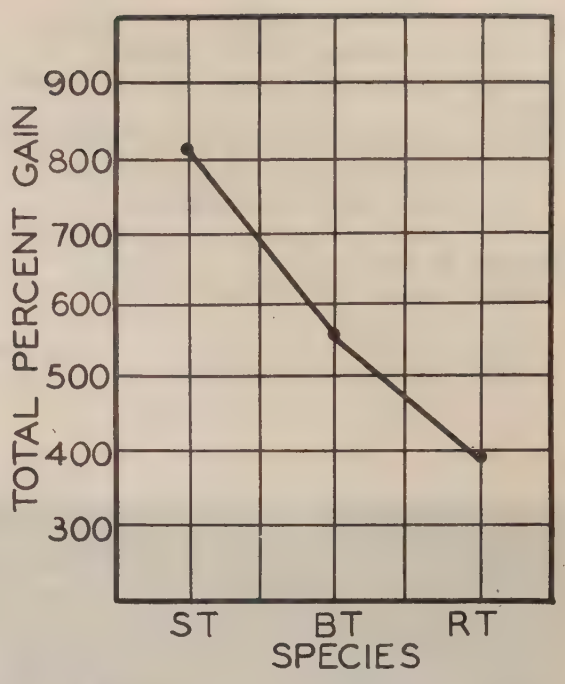
It should be noted that the losses recorded in table 2 for the brown trout receiving cod-liver oil were much greater than for the brown trout which received no oil. Such a difference was not apparent for either brook or rainbow trout. The increased loss when oil was added to the diet, would more than nullify any beneficial effects from the increased rate of growth. The brown trout of all four troughs (both with and without cod-liver oil) were suffering from "slime patch" disease. It is possible that the increased rate of growth caused by the addition of the oil exaggerated the diseased condition and thus resulted in an increase in mortality. Rodgers (1949) has shown that "slime patch" can be corrected by the addition of treated beef liver to the diet of brown trout, thus pointing to "slime patch" as a deficiency disease. If this is true, then an increase in the rate of growth might well intensify the need for the substance that is lacking and thus magnify the losses considerably. It is believed significant that in another series of experiments brown trout held for other purposes and given an all-meat diet, did not show any symptoms of "slime patch" and normal, expected losses were recorded.

TABLE 2.--Summary of cod-liver oil experiments

Trough No.	Species	Average weight (start) (grams)	Average weight (end) (grams)	Gain weight (grams)	Total gain (percent)	Total conversion	Average mortality (percent)
1	Brook	1.21	13.3	12.09	999	3.5	0.32
2	Brook	1.21	12.9	11.69	966	3.9	0.15
3	Brook	1.21	8.9	7.69	635	4.2	0.17
4	Brook	1.21	8.8	7.59	627	4.2	0.28
5	Brown	0.55	4.2	3.65	663	5.4	12.45
6	Brown	0.55	4.5	3.95	718	4.3	10.07
7	Brown	0.55	2.9	2.35	427	5.6	2.25
8	Brown	0.55	2.9	2.35	427	5.2	4.16
9	Rainbow	2.59	14.5	11.91	459	4.4	0.23
10	Rainbow	2.59	15.1	12.51	483	4.4	0.25
11	Rainbow	2.59	10.6	8.01	309	6.7	0.17
12	Rainbow	2.59	11.2	8.61	332	5.5	0.10



DIET VS. TOTAL GAIN



SPECIES VS. TOTAL GAIN

This laboratory has reported previously (Phillips et al., 1947) that brown trout required a greater amount of biotin than did either brook or rainbow trout. Biotin is concerned with growth in the animal body. An intensified rate of growth might well intensify the need of the body for this vitamin. Beef liver is an excellent source of this vitamin, and Rodgers has shown that beef liver will correct "slime patch" disease. If future experiments show that biotin is the substance in beef liver that prevents "slime patch," the increased mortality caused by the addition of cod-liver oil to the diet of brown trout could be readily explained. For the present it would be safe to assume that such is the case and add beef liver to the diet of these fish, whether cod-liver oil is used or not.

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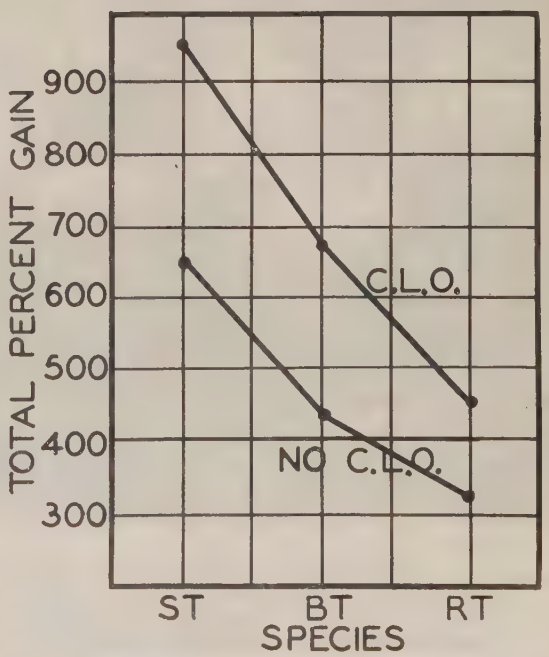
1939. Fingerling trout feeding experiments, Leetown, 1938. Prog. Fish-Cult. 45: 32.

Gutsell, J. S. (continued)



SPECIES VS. TOTAL GAIN
TWO DIETS COMPARED

Phillips, A. M.; Brockway, D. R.; Rodgers, E. O.; Robertson, R. L.; Goodell, Herbert; Thompson, J. A.; and Willoughby, Harvey.
1947. The nutrition of trout, Cortland Hatchery Report 16. N. Y. Cons. Dept., Albany, N. Y.

Rodgers, E. O.
1949. Dietary observations on brown trout fingerlings. Prog. Fish-Cult. 11 (2): 130-132.

Tunison, A. V.; Phillips, A. M.; Rodgers, E. O.; Mitchell, C. R.; and McCay, C. M.
1939. The nutrition of trout, Cortland Hatchery Report 8. N. Y. Cons. Dept., Albany, N. Y.

Hatched in midsummer of 1947 at the U. S. Fishery Laboratory at Beaufort, North Carolina, this diamond-back terrapin--whose two heads have appeared in Life, News Week, and many newspapers throughout the country--is apparently doing well on a diet of raw sheep liver and a series of sun-lamp treatments at the National Aquarium (under the direction of the Fish and Wildlife Service and located in the Commerce Building, Washington, D. C.)

ERADICATION OF EMERGENT AQUATIC VEGETATION WITH 2,4-D

PARTICULAR EMPHASIS UPON ALLIGATORWEED

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DURING THE past few years many compounds of 2,4-Dichlorophenoxyacetic acid, generally known as "2,4-D," have been developed for use as herbicides. The esters and salts of the acid, used in water or oil bases or in powder form, have received the most attention from research workers in this field. With these herbicides, much excellent work has been done in the control of obnoxious plants--probably more than has been directed toward eradication. Insofar as agriculture is concerned, the eradication of undesirable plants by chemical means is seldom practical because a concentration of the active ingredients sufficient to result in eradication would have a deleterious effect upon the desirable plants. Very practical control frequently can be obtained, however, by the use of minimal amounts of 2,4-D in some one of its various forms, the particular form of the acid used depending upon the toxicity levels of the plants concerned. Outstanding work in this field has been done by C. A. Brown and his associates at the Agricultural Experiment Station of Louisiana State University, where the growth of alligatorweed in fields of rice and cane was so retarded by light sprayings of 2,4-D that phenomenal yields were obtained.

T. F. Hall, biologist of the Tennessee Valley Authority, conducted extensive tests on the efficacy of various formulations of 2,4-D on trees, shrubs, grasses, and aquatic plants of the lakes and watersheds of the T.V.A. area. As a result of these tests, he classified 82 species into groups of high, medium, and low susceptibility to the effects of 2,4-D. Although no intensive work was done in its control, he placed alligatorweed in the "medium" group in comparison with the other plants tested. It is worthy of note that, from the standpoints of cost and effectiveness of treatment, he found airplane application the most satisfactory method of treating large areas.

Much basic work on the eradication of undesirable vegetation from fishponds has been done by E. W. Surber, U. S. Fish and Wildlife Service, at the Experimental Station at Kearneysville, West Virginia. He has found that for most emergent aquatic plants, 2,4-D in kerosene with tributylphosphate as a cosolvent produces the best results. A water solution of 2,4-D with triethanolamine as the cosolvent is slightly less efficacious than the tributylphosphate mixture, usually

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With headquarters now at the Leetown Station of the U. S. Fish and Wildlife Service at Kearneysville, West Virginia, Mr. Cornell is doing research for his Ph.D. degree at Virginia Polytechnic Institute. His appointment as a collaborator with the Fish and Wildlife Service has recently been approved.--The EDITORS.

requiring a higher percentage of 2,4-D to obtain comparable results, but having the advantage that the triethanolamine is relatively nontoxic to fish. The comparative effectiveness of these two sprays has been verified by the unpublished experimental work of H. W. Jackson, biologist of Virginia Polytechnic Institute, in tests conducted near Blacksburg, Virginia.

The immediate incentive for experimental efforts to eradicate alligatorweed was the fact that abandoned rice fields along the South Carolina coast, which once provided the winter food for many ducks of the Atlantic flyway, have been so invaded by the weed as to cause a serious depletion of desirable food plants in the area. With the aim of complete eradication in mind, the most potent spray obtainable (within the limits of economically practical application) seemed indicated. At the suggestion of E. W. Surber, the composition of the spray used was that of the free acid dissolved in tributylphosphate and mixed with kerosene to give a 5-percent solution of 2,4-D. The spray was applied at the rate of 30 gallons per acre, this being the minimum possible with the spraying equipment at hand, although Surber has found 20 gallons per acre adequate for most emergent aquatic plants. No other compounds of 2,4-D were tested for comparative results in the experiments conducted during the period of August to December 1948, at Bear's Bluff Laboratories, Wadmalaw Island, South Carolina. Several plants other than alligatorweed were sprayed incidentally in order to compare the results with the work mentioned.

In evaluating the findings in the following notes, two important considerations should be borne in mind. Because of maximum photosynthetic activity, "hormone type" herbicides seem to be most effective in the spring, when the plants are growing most rapidly. These tests were conducted early in the fall, when, in the latitude of the South Carolina coast, plant growth was considerably diminished. Also, the observations covered a period of only 4 months. It will be impossible to determine the exact extent of eradication obtained until the advent of a new growing season proves whether or not any of the roots are viable.

SPECIES TESTED

Alligatorweed or "pigweed" (Alternanthera philoxeroides)

A metal trough, 2½ feet by 8 feet by 7 inches deep, was divided laterally at the middle with a board. Soil was sloped up from the ends toward the middle so that when the trough was filled with water there would be all depths from a full 7 inches at the ends to exposed mud flats in the middle. The whole trough was then planted with alligatorweed from the laboratory pond, and 2 weeks were allowed to elapse so that the plants might become thoroughly acclimated. On August 11, by which time all plants were growing well, one-half (control) of the trough was covered with a tarpaulin and the remainder was sprayed at the rate of 30 gallons per acre, as nearly as could be determined. Within 2 hours the sprayed plants had turned a very dark green and were appreciably wilted. At the end of 24 hours, the plants were black with brown-tipped leaves and lay nearly flat. At the end of 2 days, the exposed portions--both stems and leaves--of the plants were brown and apparently dead. The submerged rhizomes and leaves remained green, but there was a swelling at the nodes, and the plants gradually broke up at these points and decay progressed into the internodes. On September 11, a month after spraying, there was no regrowth and the emergent parts appeared to be dead. The control plants remained healthy and growing.

On September 15, the dead emergent parts were removed and that same half of the tank was replanted. On September 22, a week later, the new plants had shown no ill effects from being placed in the soil and water which so recently had been treated with the lethal spray. This points to the assumption that there was no appreciable residuum of the acid.

It was decided then to determine whether this basic spray could be diluted further with kerosene and still retain its lethal effect insofar as alligatorweed

was concerned. The plants which had served as controls during the previous test and had not been exposed to the spray, were transplanted to metal aquaria in which previously had been placed a 6-inch layer of wet soil and an additional inch of water. One acuarium was retained as a control, one was treated with the full-strength spray as a replication of the previous test, and the remaining six were arranged in pairs for the dilution tests; thus duplicates were provided in each case. For the first pair, a spray was made up of equal parts of the basic spray and kerosene, containing 2.5-percent concentration of 2,4-D. In a similar manner, a spray of 1.25-percent concentration was prepared for the second pair, and a spray of 0.625 percent for the third pair. The plants in the control aquarium remained healthy throughout the duration of the test, and those which received the 5-percent spray followed the general course described for the previous test, that is, they were apparently dead in 2 days. Of the three remaining pairs, the results of their respective diluted sprays were as follows:

September 22	- Plants sprayed as indicated.
1 day later	- First, very slightly wilted. Second and third, no apparent effect.
2 days later	- First, slightly wilted and brown-tipped leaves. Second and third, slightly wilted.
3 days later	- First, some leaves entirely brown. Second and third, infrequent brown spots on leaves.
1 week later	- First, 90 percent of leaf area yellow. Second, 60 percent of leaf area yellow. Third, 40 percent of leaf area yellow.
2 weeks later	- First, plants entirely yellow with some disintegration at nodes. Second and third, a few spots of green remaining on leaves, the stems generally yellow but swollen at the nodes.
1 month later	- All plants in the three pairs of aquaria entirely brown, with considerable breaking at the nodes of emergent parts. In the first pair, each aquarium contained a new sprout from the root. In the second and third pairs, each aquarium had several new sprouts.

At this point the test was discontinued. It was evident that the full-strength spray caused a deterioration of the complete plant, whereas the various dilutions killed the emergent parts in 3 to 4 weeks but left the roots in a viable state so that new shoots could be produced. It might be assumed that the new shoots would have appeared even more quickly if this spraying had been conducted during the spring.

After it became apparent that the 5-percent concentration of 2,4-D was the minimum which might accomplish eradication under controlled conditions, and that dilutions were relatively ineffective, it was decided to test the efficacy of the basic spray on the weed in its native habitat. Mr. Walter Renken of Charleston, South Carolina, offered the use of the abandoned rice fields on his Long Brow Plantation (which had been "taken over" by alligatorweed) as a site for further experiments. The plant grew there in situations ranging from dry and exposed dykes--and rooted in the old fields but covered with 1 inch to 2 feet of water--to canals containing 5 feet of water, where the plants were free-floating. On October 12, test plots were sprayed in the various type locations (selected where the growth was particularly dense), and

the results were comparable to those obtained in the tests at the laboratory. Within 2 hours a darkening and wilting of the leaves was apparent, and in 2 days the emergent parts were completely brown and dead. This was equally true of the rooted and the floating plants. Whether or not there may be any eventual regrowth, cannot be stated with certainty until the spring of next year provides a new growing season.

On December 14, the rhizomes of the plants which had received the first test spraying in the metal trough were unearthed and inspected. During the 4-month period since those plants were sprayed, decay at the nodes had broken the rhizomes into short segments and the deterioration had progressed into the internodal sections. In a very few instances, however, it appeared that after the decay of the node the rhizome had healed across the end and a ring of tuberculate processes had formed. It is to be presumed that these tubercles were composed of primordial tissue which would provide new growing points under suitable temperature conditions. From these observations, it appears that the exposed portions and most of the root system of a stand of alligatorweed will be destroyed by one application of the 5-percent spray, but that some weeks later there may be a slight resprouting which will require a subsequent treatment to effect total eradication.

Cattail (Typha latifolia)

The spraying of cattails produced results comparable to those obtained by Surber (1947), but not so quickly. Logically, a more delayed reaction could be expected, as the growing season was nearly concluded at the time of spraying. Surber found that within 2 days after treatment the sprayed plants became bleached and apparently had died. In the tests conducted on the Bear's Bluff ponds, not until 2 days after spraying did any bleaching effect become evident--and that only in small spots. The bleached spots grew progressively larger, however, until at the end of 10 days the plants were yellowish-brown and appeared completely dead. During the subsequent 4 months, decomposition took place to the extent that the leaves broke over or lay flat in the water. There has been no recovery.

Soft-stem Bulrush (Scirpus validus)

Two test patches of the locally common soft-stem bulrush were sprayed, and the results were slow but very positive and thorough. A week after spraying, the first evidence of chlorosis began to appear near the tips of the stems. This slowly progressed downward, and 3 weeks were required for the plants to assume an appearance of being completely dead. Disintegration has continued until the plants are obviously beyond recovery, and no resprouting has taken place.

Dwarf Palmetto (Sabal minor)

Although this cannot be classified as an obnoxious plant in local freshwater ponds, one frond was inadvertently sprayed while other plants were being treated. The emergent part of the plant became chlorotic in appearance, similar to the cattails. The submerged part of the plant remained green, however, and continued to do so for 4 months. Though there has been no regrowth nor resprouting, it is not possible to say that the plant is dead.

Duckweed (Spirodela polyrhiza)

This plant, also, was sprayed inadvertently; but the mats of it were so dense, it could not be avoided. The reaction was quite rapid in that the plant lost its green color, assumed a lead-gray appearance, and sank within 24 hours. The observance of this occurrence was quite difficult because additional plants drifted into the area almost immediately when the sprayed plants finally sank.

Banana Waterlily (Nymphaea flava)

This particular species of waterlily failed to exhibit the resistance to the action of 2,4-D which was noted by Surber (1947) in his work with an ornamental variety of Nymphaea and with Nuphar advena.

Nymphaea flava was killed by following his suggested procedure of successive sprayings as additional leaves appeared at the surface. Twenty-four hours after the first spraying, the emergent leaves had become a watery lead-gray in color and they soon sank to the bottom. Additional leaves, which had been submerged at the time of spraying, came to the surface during the following 3 days. These leaves were approximately one-fourth as numerous as the original group and somewhat smaller. Five days after the original spraying, the second group of emergent leaves was sprayed, with the same result as before. Subsequently, only a few scattered leaves appeared, very noticeably smaller than their predecessors. After another 5 days, the few newly emerged leaves were sprayed. There were no additional submerged leaves visible at the time of the third spraying, and during the next 4 months there was no regrowth from the roots. Although there may be a regrowth in the spring, it seems reasonable to conclude that this test plot of lilies, originally some 8 by 18 feet in extent, is dead.

Cat Brier (Smilax Bona-nox var. littoralis)

Although Smilax is not an aquatic plant, it is included here as a matter of interest because of its extreme susceptibility to the spray used. This plant is prevalent on the wooded pond banks, and its manual removal is at best an unpleasant task; but when only a part of the plant received the spray--even in very small quantities--the whole plant died within a day. In one instance, a plant 18 inches tall was so protected that only the two terminal leaves were exposed; yet when these two leaves were sprayed, the plant died.

SPRAY PREPARATION

For the benefit of anyone who wishes to use this spray (which is believed to be unavailable commercially), its preparation is described. Two pounds of 2,4-D powder as the free acid are dissolved in 2 quarts of tributylphosphate, and the solution is made up to 5 gallons with kerosene, resulting in a 5-percent solution of 2,4-D. An oil-soluble dye, incorporated with the kerosene before the other ingredients are added, will give the spray any desired color. This is helpful in indicating coverage and preventing unnecessary effort and waste of materials. The current price of materials makes the spray cost approximately $1 per gallon.

CAUTION

It should be noted here that tributylphosphate is toxic to fish, and the spray should be used with caution in waters where the preservation of the fish crop is a consideration. In testing mixtures of this compound with water in aquaria, Surber found concentrations in excess of 15 parts per million to be toxic to sunfish. It appears, however, that in the treatment of a dense growth of emergent vegetation, most of the spray remains on the plants and a relatively small amount reaches the surface of the water. In the first experiment described, where a 5-percent spray was used at an estimated rate of 30 gallons per acre, Gambusia minnows (Gambusia affinis) and leopard frogs (Rana sphenocephala) which were placed in the tank at the time of preparation, had shown no ill effects at the conclusion of the experiment.

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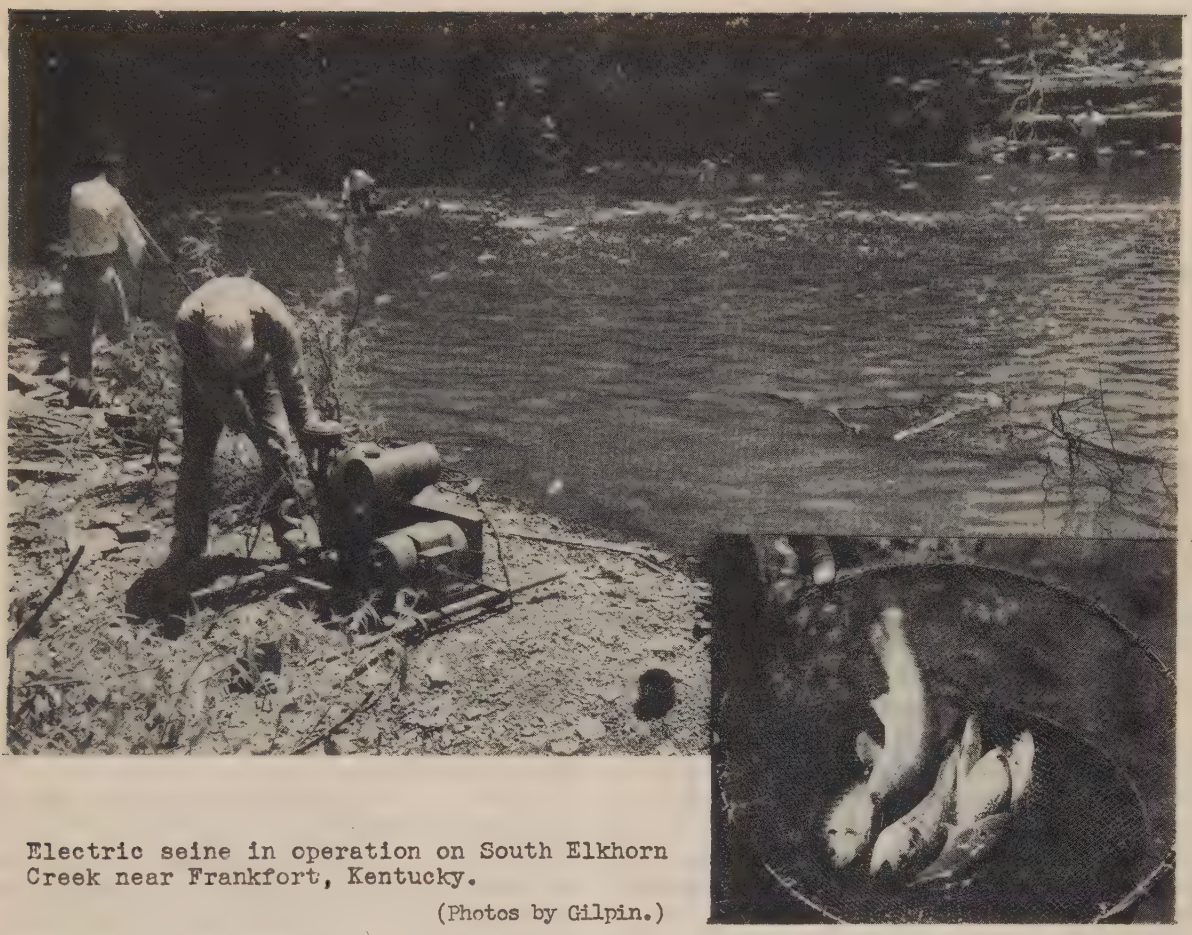
THE JOY OF BEING AN EDITOR

Getting out this magazine is no picnic.
If we print jokes, people say we are silly;
If we don't, they say we are too serious.
If we stick close to the office all day,
We ought to be around hunting material.
If we go out and try to hustle,
We ought to be on the job in the office.
If we don't print contributions,
We don't appreciate genius;
And if we do print them, the paper is filled with junk!
If we edit the other fellow's write-up, we're too critical;
If we don't, we're asleep.
If we clip things from other papers,
We are too lazy to write them ourselves;
If we don't, we are stuck on our own stuff.
Now, like as not, some guy will say
We swiped this from some magazine. *

*We did! —The Fisherman, November 1948.

Pools and spawning buildings of U. S. Fish-Cultural Station, Berlin, New Hampshire.



Electric seine in operation on South Elkhorn Creek near Frankfort, Kentucky.

(Photos by Gilpin.)

ELECTRIC SEINE USED IN KENTUCKY

Leonard Joeris
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The electric seine used by the Kentucky Division of Game and Fish is a variation of the seine described by John T. Funk of the Missouri Conservation Commission in his article, Wider Application of the Electrical Method of Collecting Fish (77th Annual Meeting, American Fisheries Society).

The power plant used on the Kentucky seine is an alternating-current generator, belt-driven by a single-cylinder 4-cycle air-cooled gasoline engine that develops 6½-horsepower at 2,400 revolutions per minute. The generator, driven at a speed

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See also:

Shetter, D. S.
1948. The electric "shocker" and its use in Michigan streams. Prog. Fish-Cult. 10 (1): 43-47. (Reprinted from Mich. Cons. 16 (9): 8-10. October 1947.)

(Drawings courtesy of author.)

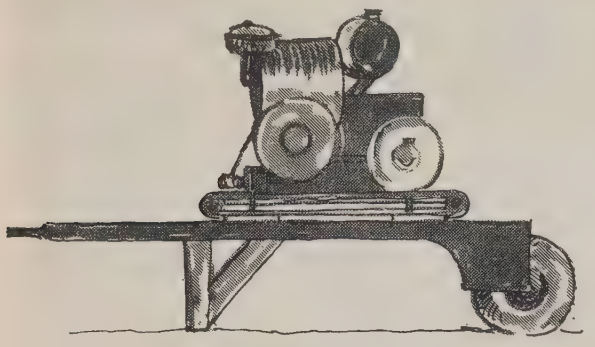

FIGURE 1.

of 1,800 revolutions per minute by means of dual "V" belts, develops 2,500 watts and 120 volts. This generator is considerably larger and more powerful than most generators in use for electric seines or shockers throughout the United States at the present time.

The weight (330 pounds) of this generator has been the greatest draw-back to its use in the field, but this problem has been eliminated to a large extent by mounting the generator on a wheelbarrow made of 2- by 4-inch oak and using a standard 6-inch airplane wheel with a 600 by 6 tire (figure 1). This wide, low-pressure tire operates equally well over soft ground or coarse gravel and rubble, and it is easily moved by two men.

The electric seine is usually operated without a boat by placing the power plant on the bank or in the bed of the stream where the water is not more than 18 inches deep. Areas that are inaccessible from a fixed position are reached by placing the generator and carriage in a boat of sufficient size to float the power-plant equipment and one man.

The seine used by the writer (figure 2) consists of a two-strand rubber-coated cable of No. 12 wire, 150 feet long. The first 50 feet of the cable form a lead wire from the generator. A probe pole is securely attached to the cable at either end of the remaining 100 feet. These probe poles are 7 feet long and tipped with a strip of copper plate (20 inches long and 3/4 inch wide) folded over the lower end. The seine between the two probe poles is held up by 14 floats made from 18-inch sections of 2- by 4-inch lumber. Twenty-seven additional electrodes of two types are spaced at 3½-foot intervals between the two probes. Fourteen of the electrodes located at 7-foot intervals are made of a strip of hardware cloth (12 inches wide) wrapped completely around the center of each float (figure 2). All these electrodes are connected to the same strand of wire leading from the generator. The remaining 13 electrodes and the 2 probe poles are connected to the other strand of wire within the cable. These electrodes, made of 12-inch pieces of heavy brass welding rod, are connected to the main wire by 5-foot drops made of No. 18 rubber-coated lamp cord (figure 2). The two strands of this wire are twisted together and used as a single wire. The drops are attached at 7-foot intervals at the midpoint between each float. The point at which each drop is attached has been taped securely to insulate and to strengthen the joint. If this is not done, the drop cords soon break off.

Most of the operation of the seine has been carried on by a crew of two or three men. In smaller streams only one of the probe poles is carried, but where the wider streams are studied, one man operates each pole. He is usually equipped with rubber gloves and hip boots and carries the probe pole in one hand and a long-handled dip net with a deep bag in the other. The deep bag enables each man to pick up a large number of fish in his net without danger of releasing any of those taken on previous dips. The third man, pulling a floating box or tube attached to his belt by a 3- to 4-foot piece of rope, collects fish from both of the probe operators and picks up all the fish he can as he moves back and forth across the stream following the seine. The collecting man usually remains about 3 to 6 feet behind the seine. If he follows the seine at a greater distance, some of the shocked fish settle to the bottom and are easily overlooked.

Rubber gloves are used for several reasons, one of these being to protect larger fish that are handled for tagging or scale-sample removal. Another reason is the comfort the gloves offer when the

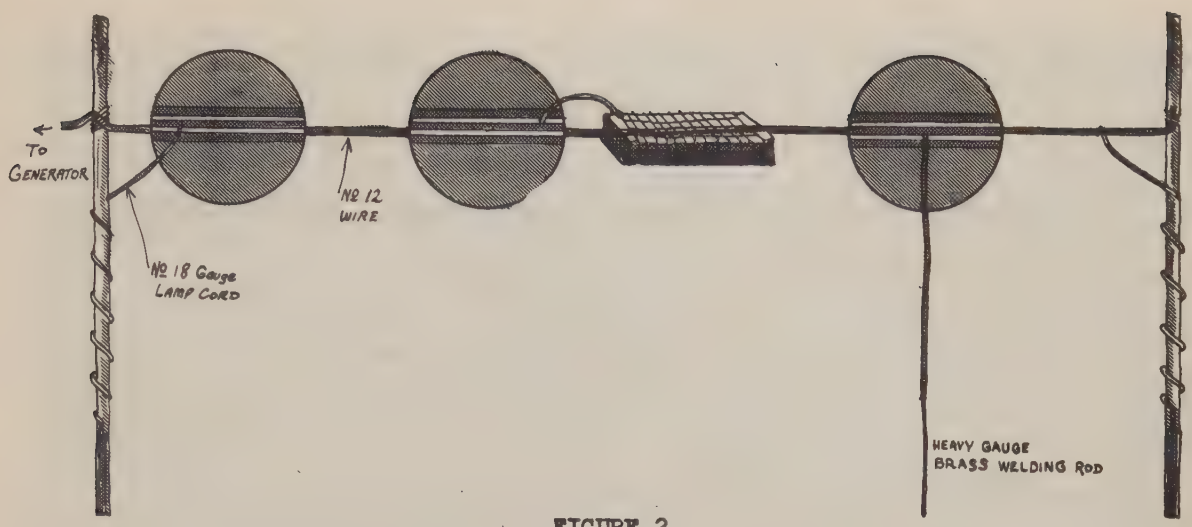

FIGURE 2.

seine must be handled to free it from various obstructions. Rubber boots are used in shallow areas where there is little danger of getting water over the top of the boots. Hip boots full of water are more uncomfortable than the small electric shocks a man receives in the normal operation of the seine.

The intensity of the electric shock increases as the worker nears either type of electrode and decreases as he steps back. The writer found little discomfort without boots if he maintained a minimum distance of 14 to 18 inches from the electrode while the generator was operating. Several individuals have received rather unpleasant but harmless shocks when they contacted two or more of the electrodes at one time.

The seine works very well in relatively clear water less than 4 feet deep. The seine shocks all species of fish equally well, but the large fish seem to be shocked more successfully than the small fingerlings and fry. A few of the stunned fingerlings may be killed if they remain within the charged field too long. If the seine is moved slowly, little danger of killing fish is apparent. All species of fish recover rapidly and they sustain no damage. Some experimental fish have been shocked 10 to 12 times and are still in good condition. Game fish usually recover more rapidly than rough fish. Depth of water seems to be the greatest limiting factor in using this seine. Unless a net or other obstruction is available in deeper water, the fish are driven ahead of the seine and very few are taken until they are concentrated in shallow water or against some other obstruction placed in the stream. No attempt has been made in this article to evaluate the success of the seine in various types and conditions of water because insufficient reliable data have been collected.

EPISTYLIS, A PERITRICHOUS PROTOZOAN, ON HATCHERY BROOK TROUT

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On November 24, 1944, during the investigation of a slight increase in the mortality rate among yearling brook trout (Salvelinus f. fontinalis Mitchill) in concrete raceways at the Osceola State Fish Hatchery, a peritrichous protozoan belonging to the family Epistylidae was found in large numbers on the body surfaces and, to a lesser extent, on the gills of these fish. A number of gyrodactylid worms were also found. Examinations of 5-inch fingerlings and of adult brook trout in the other raceways revealed heavy infestations with both the protozoan and the worm. About 75 fish of different ages were checked in the following week, and all were infested. In all probability, the brook trout population in these raceways was 100-percent infested. As the fish were infested with both protozoan and worm, it was not possible to ascertain the degree to which each of these forms contributed to the increase in the mortality rate. In subsequent years, however, increases in the mortality occurred when only the protozoan was present.

On March 7, 1945, investigation of an increase in the mortality among yearling brook trout maintained in concrete raceways at the Bayfield State Fish Hatchery, revealed a heavy infestation of Epistylis occurring on the gills and, to a lesser extent, on the body surfaces. As at the Osceola hatchery, gyrodactylids were present, although in very moderate numbers.

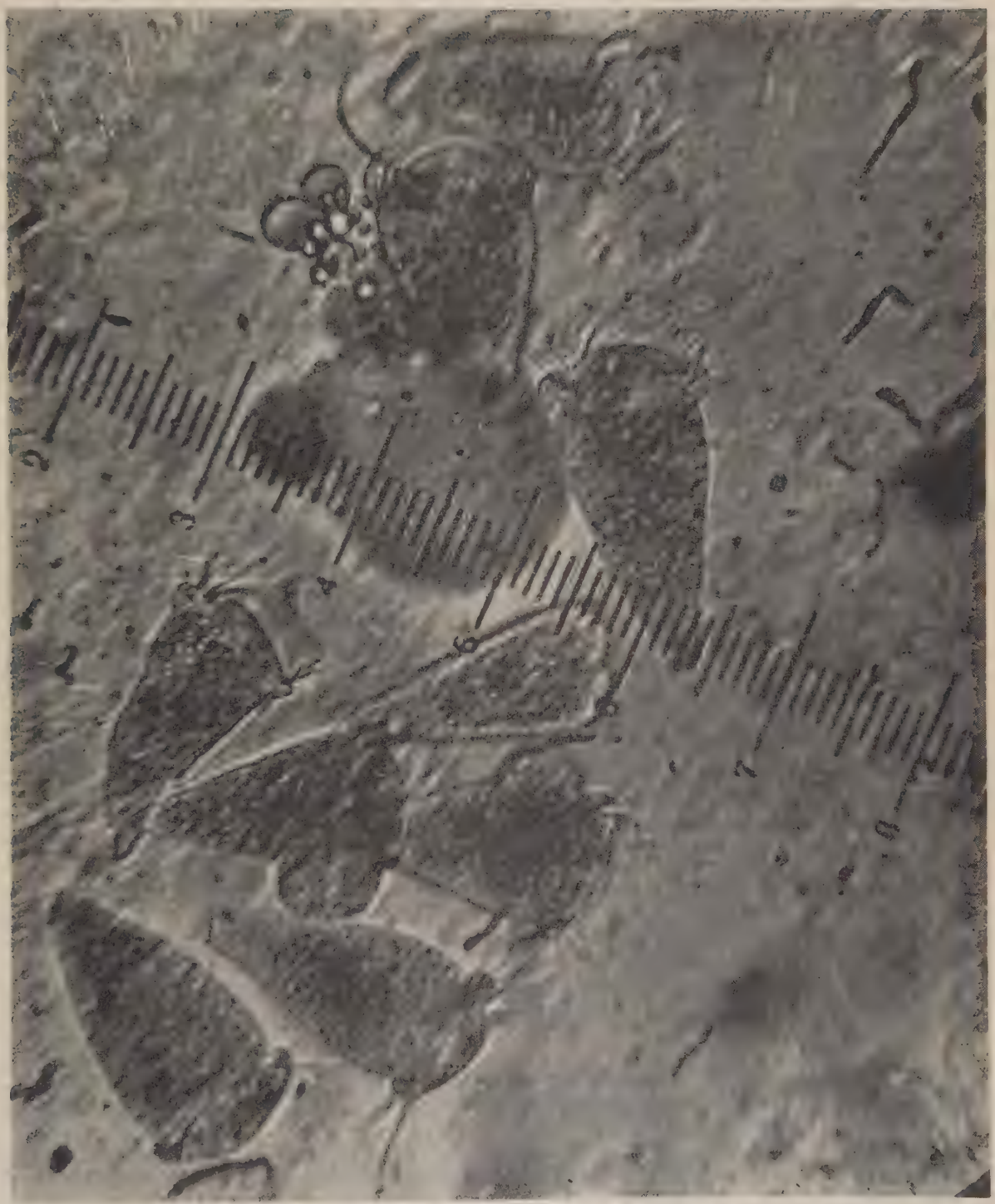
DESCRIPTION

Epistylis has the characteristic inverted bell form of the genus (see figure). The body is not annulated. The stalk is narrow, clear, and noncontractile. Individuals are seen on dichotomously branching stalks, forming colonies. Some of the peritrichs found were solitary and possessed a noncontractile stalk. The length of the stalk varies considerably, sometimes being as much as twice the length of the body. Fine surface striations occur on the posterior tip of the body and extend to the proximal tip of the stalk. The distal end of the stalk, the point of attachment to the fish, occasionally resembles a wide-spreading cuplike organ or scopula; on most, however, no scopula is visible.

The gullet is short and narrow. The contractile vacuole is close to the macronucleus. Food particles are visible in the cytoplasm, which is finely granular. At the posterior end of the body, the cytoplasm is less dense than at the anterior and is, therefore, lighter in appearance.

In normally extended individuals, the broad, crescentric to horseshoe-shaped macronucleus usually lies at the middle of the body; in contracted specimens, the macronucleus appears to lie in the posterior portion of the body. The arms of the macronucleus do not always point in the same direction for this species but may extend anteriorly or posteriorly, to the right or left, or at various other angles. The micronucleus is small and oval, lying close to and just beneath the macronucleus.

The peristome is capable of contraction, and in that position the cilia are folded so that only the tips of a few



(Courtesy of Mr. Leon D. Johnson)

Epistylis from a hatchery brook trout. (Each division of the scale equals 0.0028 mm.).

protrude from a round, centrally located opening about half the size of the normally expanded peristome. Specimens detached from their stalks were observed in a contracted state, the posterior ends of their bodies resembling large scopulas. No posterior band of cilia occurs in these detached forms. Individuals without stalks were observed attached to the fish by the posterior end, which forms a large scopula.

This species has the characteristic free-swimming telotroch larva of the group, and a band of cilia around the middle of the body in the region of the macronucleus. The body fully rounds up when the telotroch is swimming, the undulating motion of the band of cilia furnishing the propelling force.

Asexual reproduction by longitudinal fission was observed in about 15 specimens and was similar to that described for other members of the group.

TREATMENT

A 1½- to 2-minute dip in a solution of salt (3 percent) and malachite green (1:15,000) has been completely successful in killing Epistylis and has resulted in lowering the mortality rate. The use of salt (3 percent), malachite green (1:15,000), and copper sulfate (1:2,000) separately, did not kill all the protozoans. A solution of copper sulfate (1:2,000) and malachite green (1:15,000) was equally unsuccessful for the eradication of the protozoans. Apparently, the use of salt upsets the osmotic pressure of Epistylis sufficiently to permit the malachite green to enter the cytoplasm and kill the protozoan.

Reinfestation of the trout with the protozoan does take place. Reinfestation has been seen on the Osceola hatchery brook trout in 4 successive years since the first discovery of Epistylis. This is readily understandable, as in part of its life history the protozoan is free-living and, therefore, not killed by dipping the trout. Attachment to the trout can be made at any time after treatment, thus reinfesting the fish.

ACKNOWLEDGMENTS

The author wishes to express his deep appreciation to Mr. Leon D. Johnson, biologist, for his aid in determining an effective method for treatment of Epistylis and for furnishing the photograph. Appreciation is also due Mr. Locy Stewart, Osceola hatchery foreman, for his cooperation in making the hatchery and its facilities available.

BASS SPAWNING IN DECEMBER

"Two large nests of bass eggs and many other bass on nests," reported Dudley B. Heiliger, Superintendent of the U. S. Fish-Cultural Station at Lyman, Mississippi, on December 19, 1948. This activity was noted in the bass brood pond at the station after several days of warm weather.

The station records indicate that these were mature fish that had spawned previously: they were not late-spawning young fish.

Search of the files of the Fish and Wildlife Service has not yielded any other record of bass spawning at this period of the year at a Federal hatchery in the United States.

PROGRESS IN RECLAMATION TECHNIQUES

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Concord, New Hampshire

The practice of reclaiming ponds for trout by poisoning undesirable fish has become one of New Hampshire's established and accepted fish-management techniques. As only about 200 of New Hampshire's approximately 1,500 lakes and ponds are salmonoid waters, our reclamation efforts have been concentrated upon establishing more trout ponds. To date, we have reclaimed 48 ponds, which range in size from 4 to 355 acres. With but few exceptions, fishing for trout in these ponds has shown remarkable improvement. The purpose of this report is to acquaint other fishery men with some of our latest trials, errors, and successes in this work.

The several new developments incorporated in our current use of rotenone originated with, and were perfected by, our fishery technicians under the field direction of the junior author. The greatest improvements were made in methods of distributing the poison.

In our first feeble attempts, paper bags filled with the solution were thrown on the water, where they burst and spread the solution. To supplement this, pails filled with rotenone in liquid form were also emptied into the lake.

The next phase consisted of tying burlap sacks filled with derris powder to the stern of a boat, then dragging the sacks back and forth through the water until they were emptied.

As the work continued, it soon became evident that even distribution was highly desirable, for we found that a fine film evenly distributed over the entire surface of the lake was far more effective than heavy but spotty concentrations of the solution. This led to our next advance--the use of spray pumps. Indian spray pumps operated from boats to cover open water and to reach surrounding marshes and inlets, proved more effective than our earlier methods.

Particularly where large bodies of water were involved, securing sufficient manpower presented a major problem; hence we were constantly seeking ways and means to reduce the amount of labor required. To this end, orchard pumps were pressed into service. These worked well but still required considerable manual effort.

Finally, a rotary-type pump from a fish truck, discarded by our fish-propagation division, solved the problem of distributing rotenone from a boat. With this apparatus (figure 1) two men were able to cover open water much more quickly, while others were relieved to devote their efforts to covering the shore with spray pumps.

Rotary-type Fish-truck Pump

A large hose attached to the intake of the pump draws up the rotenone solution. A short length of garden hose is placed on a reducing tee which has been attached to the outlet of the pump. As the rotenone is forced through the garden hose, the operator sprays the solution over the surface of the water.

To fill the cans with water, the free end of the intake hose is placed in the lake and the garden hose is directed into

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See also:

Siegler, H. R., and Pillsbury, H. W. 1947. Use of derris to reclaim ponds for game fish. Prog. Fish-Cult. 9 (2): 104-110. (Reprinted from Jour. Wild. Mgt. 10 (4): 308-316.)

(Courtesy of author)

FIGURE 1.--Power sprayer: rotary-type fish-truck pump being used to distribute the rotenone solution

the cans. While water is being pumped in, a previously prepared solution of rotenone is slowly poured into the cans. The action of the incoming water assures a thorough mixing of the solution.

Application from the Air

The power pump has speeded operations on open water considerably. Though the use of this apparatus reduced labor and expedited operations on open water, the task of covering extensive mud flats and undrained pools which surrounded our larger lakes after they were drawn down, was still causing us many difficulties. To meet these, we determined to attempt the use of an airplane. A local concern offered to provide a plane and pilot at $20 an hour.

The plane used is a two-seater, Navy-Trainer biplane model (figure 2). The front seat has been removed and replaced by a 50-gallon metal drum laid lengthwise. A hole has been cut in the upper side of this drum to receive a 3-inch hose, through which the drum is filled. In the lower side, two 2-inch outlet holes have been fitted with 2-inch pipes; one of these pipes is extended along the under side of each of the plane's lower wings, suspended about 6 inches from the wing to permit a free flow of air. At first we used pipes pierced with rows of 1/4-inch holes, but we soon replaced these with pipes having a 1-inch hole at the center of each span and the ends open. Through these pipes the rotenone solution flowed freely, breaking into a fine spray as it left the two openings in each pipe.

At first we thought that the rotenone would have to be forced from the drum; consequently, we had a Venturi tube placed at the top of the plane, behind the propeller, to utilize the wind pressure. We soon discovered, however, that the solution drained from the drum rapidly enough without the wind pressure; in fact, the 50-gallon drum could be emptied of

(Photo by Uel A. Gardner, Farmington, New Hampshire)

FIGURE 2.--The front seat has been removed and replaced with a 50-gallon drum. Note outlet pipes beneath wings.

its load in 40 seconds, if necessary. To load, the airplane would land in a nearby field, where four men mixing the poison worked at top speed to keep the plane supplied as it shuttled back and forth from the lake to the field. The pilot's job was to spray the mud flats (on large lakes) while other men were spraying the deeper water from boats.

Power Mixer

There were, however, still several difficulties to overcome. When the plane was used, the rotenone solution was distributed faster than the men could mix it. To eliminate this delay, our men devised a power mixer (figure 3) made from an automobile fan. The blades of the fan were removed; only the bases of the blades were left. This apparatus was powered by a 1½-horsepower motor attached by a flexible cable, and the speed of the revolutions was cut by reduction pulleys to 300 revolutions per minute. The new equipment speeded operations considerably. Where formerly it took about 7 minutes to mix a batch of poison, it now took approximately 1 minute.

Finance

Of course, the nearer the landing field to the area of operation, the more economical becomes the job. A nearby source of water with which to mix the derris powder (or emulsifiable rotenone, if this is used) is essential.

During the summer of 1947 we used an airplane on five different reclamation jobs. The plane was based at Concord, New Hampshire, but loaded close to the scene of operations. From Concord, the distance to each of the ponds ranged from a minimum of approximately 25 miles to Club Pond, to 130 miles to Back Lake. A breakdown of the costs involved, as well as the percentage of the total costs

Lakes reclaimed, the cost of operation, time required for each operation, and the percent of the total costs

Back Lake	Nash Bog	Whittemore Lake	Stone Pond	Club Pond	Summary
13 hrs. 21 min.	6 hrs. 45 min.	4 hrs.	4 hrs. 45 min.	2 hrs.	30 hrs. 51 min.
400 lbs.	250 lbs.	200 lbs.	100 lbs.	50 lbs.	1,000 lbs.
358 acres	223 acres	55 acres	52 acres	20 acres	708 acres
$267.00	$135.00	$80.00	$95.00	$40.00	$617.00
Actual time logged to and from base of operation:					
5 hrs.	2 hrs. 30 min.	1 hr.	1 hr. 30 min.	-	10 hrs.
$100.00	$50.00	$20.00	$30.00	-	$200.00
$0.25 per lb.[1]	$0.20 per lb.	$0.10 per lb.	$0.30 per lb.	-	$0.21 per lb.[2]
37.4 percent[3]	37.0 percent	25.0 percent	31.5 percent	-	32.4 percent
Pilot's personal inspection of landing and take-off area:					
31 min.	-	15 min.	-	-	46 min.
$10.33	-	$5.00	-	-	$15.33
$0.026 per lb.	-	$0.025 per lb.	-	-	$0.025 per lb.
3.8 percent	-	6.2 percent	-	-	2.4 percent
Actual time on the line:					
5 hrs. 50 min.	1 hr. 20 min.	1 hr. 45 min.	45 min.	15 min.	9 hrs. 55 min.
$116.67	$26.67	$35.00	$15.00	$5.00	$198.34
$0.29 per lb.	$0.11 per lb.	$0.175 per lb.	$0.15 per lb.	$0.10 per lb.	$0.165 per lb.
43.6 percent	19.7 percent	43.7 percent	15.8 percent	12.5 percent	32.2 percent
Actual time logged during operations (flight time):					
2 hrs.	2 hrs. 30 min.	1 hr.	2 hrs.	1 hr. 45 min.	9 hrs. 15 min.
$40.00	$50.00	$20.00	$40.00	$35.00	$185.00
$0.10 per lb.	$0.20 per lb.	$0.10 per lb.	$0.40 per lb.	$0.70 per lb.	$0.30 per lb.
15.0 percent	37.0 percent	25.0 percent	42.0 percent	87.5 percent	30.0 percent
Refueling time:					
-	25 min.	-	30 min.	-	55 min.
-	$8.33	-	$10.00	-	$18.33
-	$0.033 per lb.	-	$0.10 per lb.	-	$0.06 per lb.
-	6.1 percent	-	10.5 percent	-	3.0 percent

[1] Cost for particular phase of the operation.
[2] Average, based on cost per pound for each of the 5 ponds.
[3] Ratio of this phase to the whole operation.

for each lake, is shown in the accompanying table.

The plane was used 30 hours and 51 minutes, at a total cost of $617, to help reclaim ponds with 708 surface acres of water. Flying time during the actual operation was 9 hours and 15 minutes, or approximately 30 percent of the total time for which the State was charged for the use of the plane. The time spent in flying to and from the base of operation entailed the major part of the cost, amounting to 32.41 percent of the time the plane was involved in the various operations. Another 32.14 percent of the plane time chartered was used while the plane was being supplied with rotenone or while the pilot was having his dinner.

(Courtesy of author)

FIGURE 3.--The power mixer greatly facilitated the work of mixing rotenone solution.

New Fields

At the time of this writing, four more ponds have been reclaimed--ponds in which emulsifiable rotenone was used and in which the entire job was accomplished from a plane. One 24-acre lake was treated in 25 minutes. Studies are now under way to determine the effectiveness of this new form of rotenone and the degree of success of these last operations.

Airplane application of derris certainly appears to open new fields for fish control. The saving of labor and time brings within practical range many lakes which it would otherwise be impractical to treat. Especially is this true of lakes which are not readily accessible, and to which equipment and chemicals would be transported only under great difficulties.

Soon after the shad first began to be caught in the gill nets of the salmon fishermen of San Francisco Bay and Sacramento River, the fish were protected by State law, and the few examples occasionally smuggled into the San Francisco market sometimes brought the fishermen $5 apiece. The rapid increase of the fish, however, soon made it apparent that further protection was unnecessary, and, accordingly, in 1889 the restrictions on capture were removed. In the year named the fish were so abundant that at times they sold for 10 cents a pound. In 1892 the catch had become so large that the price at which the fish were retailed in San Francisco was only 2 or 3 cents per pound, two fish often being sold for 25 cents. At times the San Francisco Bay fishermen were able to sell their catch at only 1 cent a pound.

--Report, U. S. Commissioner of Fish and Fisheries, 1893.

DIETARY OBSERVATIONS ON BROWN TROUT FINGERLINGS

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Cortland, New York

For the past decade, because of a rather peculiar condition that has appeared, the Federal hatcheries in Region Five[1/] of the Fish and Wildlife Service have experienced serious difficulty in rearing brown trout. The hatcherymen have called this disease by various names, the most common of which has been "blue slime" or "slime patch."

Brown trout suffering from this ailment show a bluish film that may envelop the entire body. As the ailment progresses, some of the slime sloughs off, giving the trout a patched appearance. The fish become listless, lose their appetites, and eventually die in great numbers. Chemical treatments have been tried, but all have proved of little benefit. Salt baths offer a temporary relief in that the slime covering the body is removed for a period, but the actual loss of trout shows little reduction. Brook trout also suffer to some extent from this trouble, but the losses are much smaller.

The Cortland Laboratory (1947) reported that brown trout showed a greater requirement for the vitamin biotin than did either brook or rainbow trout. This offered a possible clue as to the trouble, and a series of experiments was made to determine whether diet played a role in the "slime-patch" disease.

PROCEDURE

Late in May 1948, the brown trout of the production hatchery showed a greatly increased loss and the symptoms of "slime patch" appeared. When, as a shot in the dark, treated beef liver had been fed (to the extent of 50 percent of the diet) for a short period, a definite decrease in the losses was noted. It was thought that, in view of these results, a series of experiments might shed some light on the problem.

Six troughs were set aside in the production hatchery, and several different diets were tried on the lots of fish. These diets have been listed in table 1. Diet 1, the standard diet of the hatchery, was given to the trout that served as a control lot. Diets 2, 3, 4, 5, and 6 were variations of the production diet, containing various amounts of meat products in the form of beef spleen and/or treated beef liver.

As it was conceivable that other conditions, such as bacterial gill disease (which is prevalent at this hatchery), might affect the results, all fish except those that received diet 6 were treated at intervals with pyridylmercuric acetate. The fish that received diet 6 served as a control. This experiment was run for 12 weeks, and the fish were handled according to the accepted hatchery procedure.

It should be remembered that these experiments were attempts to correct a

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1/Region Five of the Fish and Wildlife Service includes the States of Maine, New Hampshire, Vermont, Massachusetts, Connecticut, Rhode Island, New York, Pennsylvania, New Jersey, Delaware, Maryland, Virginia, West Virginia, and Ohio.--The EDITORS.

TABLE 1.--Composition of diets in brown trout experiments

Diet No.	Beef melts	Treated beef liver	Dry feed mix [1]	Blower feed [2]	Received PMA [3] treatments
	(percent)	(percent)	(percent)	(percent)	
1	50	-	50	-	Yes
1-a	50	50	-	-	Yes
1-b	50	-	50	-	Yes
2	66	-	34	-	Yes
3	50	50	-	-	Yes
4	33-1/3	33-1/3	33-1/3	-	Yes
5	-	-	-	100	Yes
6	33-1/3	33-1/3	33-1/3	-	No

[1] Fish meal, 48 percent; cottonseed meal, 24 percent; wheat middlings, 24 percent; salt, 4 percent.
[2] Beef liver, 23 percent; beef melts, 23 percent; dry feed mix, 54 percent.
[3] PMA — pyridylmercuric acetate.

condition, and they were not designed for careful analysis. The results were so interesting, however, that it has been considered desirable to pass them along.

DISCUSSION

The mortality during these experiments is shown in table 2 by weekly intervals. The greatest losses were recorded among the trout that received diets 1 and 2, in which beef spleen was the only meat. Increasing the level of beef spleen in diet 2 did not reduce the losses. It will be noted that during the first few weeks the loss in these troughs declined, as it did in all others. This decline was followed by a large increase in mortality as the experiment progressed. The beef liver fed approximately 2 weeks before the start of the experiment is thought to have been the cause of the initial drop in mortality. Trout fed diets 3, 4, 5, and 6 received various amounts of treated beef liver; and all showed a loss much smaller than the loss recorded for the trout fed diets 1 and 2.

On July 23, when the losses were at their peak in the control lot, this lot of trout (receiving diet 1) was split into thirds. Two of the groups continued to receive diet 1, whereas the third group was fed a diet composed of 50 percent each of beef spleen and treated beef liver. These diets have been listed as 1-a and 1-b in table 1. The losses after July 23 in the group originally given diet 1, are shown in table 3. The losses among the fish given diet 1-a indicate that the addition of treated beef liver caused a marked reduction in the mortality of the trout.

About the middle of July, brown trout held in raceways at this hatchery started to show an increase in mortality. One raceway that was receiving diet 5 did not show this increase, whereas two others

TABLE 2.--Mortality among brown trout fingerlings fed various diets

Period	Mortality on diet No. 1	2	3	4	5	6
6/ 4-6/10	43	56	61	71	67	106
6/11-6/17	5	11	11	13	27	14
6/18-6/24	11	7	10	13	5	20
6/25-7/ 1	8	28	4	5	12	16
7/ 2-7/ 8	19	31	6	14	16	20
7/ 9-7/15	31	19	12	6	21	15
7/16-7/22	91	42	9	9	20	20
7/23-7/29		77	5	4	12	11
7/30-8/ 5		112	6	34	12	4
8/ 6-8/12		85	8	4	12	6
8/13-8/19		134	7	3	16	5
8/20-8/26		88	4	8	10	9
Totals	208	690	143	184	230	246

TABLE 3.--Mortality after lot fed diet No. 1 was split into thirds

Period	Mortality on diet No. 1	1-a	1-b
7/23-7/29	106	58	43
7/30-8/ 5	92	4	38
8/ 6-8/12	114	1	46
8/13-8/19	73	1	33
8/20-8/26	30	1	15
Totals	415	65	175

that received no liver showed a loss and the symptoms of "blue slime" disease. The trout in these two raceways were then placed on diet 5, and almost immediately the recorded loss declined.

As a matter of interest, biotin assays were run on livers of the fish held in the experimental troughs. All troughs for which a high loss and "slime patch" symptoms were noted, held fish with an extremely low storage of biotin in their livers. Fish that received liver and showed low mortalities had a normal storage of biotin. The level of dietary biotin causing a normal storage tallied with results published by the Cortland Laboratory in 1947.

It is apparent that beef liver contained some substance or substances that produced a markedly beneficial effect upon these fish. Those fish that received beef liver showed none of the characteristics of "slime patch" disease, whereas fish that received diets 1 and 2 (containing no treated beef liver) showed the typical symptoms. Whether or not this difference was caused by the biotin content of the treated beef liver, remains to be shown.

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ON SELECTING A LOCATION FOR A FISH FARM

... It may here be suggested that the immediate vicinity of a large town is to be avoided, as the roughs, that class of population to be found in every city, have a fondness for trout; and a nocturnal visit from individuals of this stamp is generally attended by results far from pleasant. In fact the stealing of trout from a private pond is too frequently regarded by even the so-called better classes as a venial offense. In many of our States it is considered in law only as a trespass; and many have been deterred from engaging in fish-farming from want of proper protection for their crop; but unfortunately no distinction is made between fishes reared with much labor and expense and the wild denizens of the mountain brook, all, wherever found, being regarded as ferae, and their captors being liable only to a small fine and the market value of the fishes taken; in fact, Mr. Ward, of Mumford, N. Y., was obliged to suffer an imprisonment in the county jail, a few years since, for peppering with shot the carcass of a scoundrel whom he detected in the act of stealing his fishes. ... It is advisable that the ponds should be so located as to be in full view of the residence of the proprietor, and a good dog, or, better still, a pair, will generally give notice of the approach of a nocturnal visitor. We have no doubt but that the voices of our faithful bloodhounds Nero and Flora have frequently prevented the visits of poachers to our ponds.

--Practical Trout Culture, by J. H. Slack. 1872.

INEXPENSIVE MICROPROJECTOR FOR SCALE AND PLANKTON STUDY

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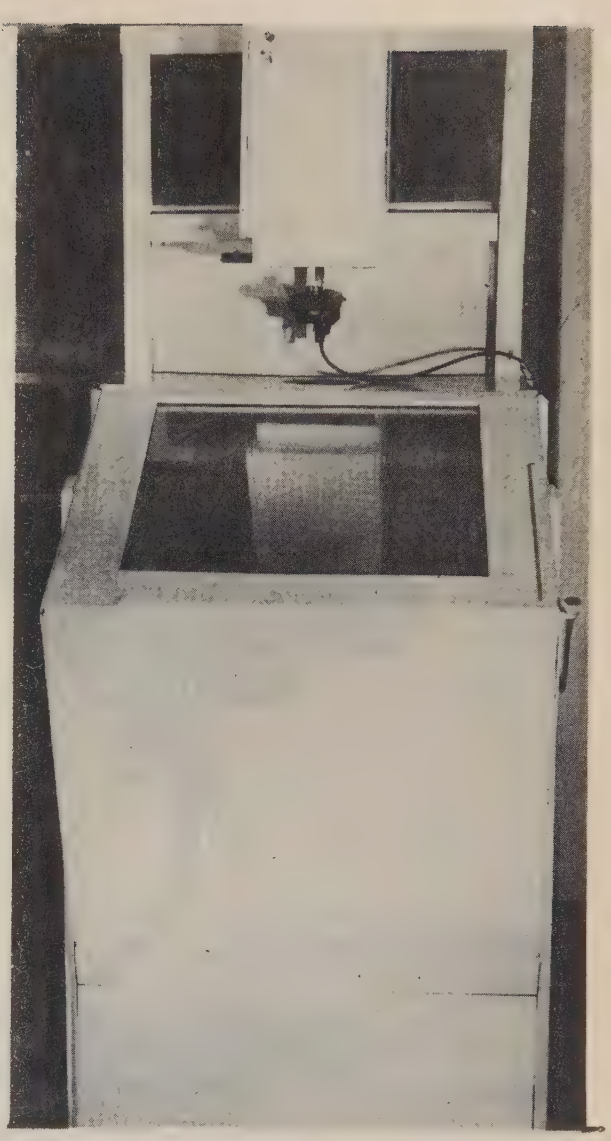
Most fishery workers can find many valuable uses for a microprojector, but the present price of most commercial projection equipment makes it unavailable to the majority of the research workers.

The projector described in this article was constructed for approximately $15. It works very satisfactorily for scale studies, plankton studies, and photographic reproductions of all objects projected on the screen. Any object viewed in a microscope can be viewed on a 20- by 20-inch screen with this machine.

The cabinet for this projector was copied from one in use by Dr. R. W. Eschmeyer of T.V.A. The lamp box is a discarded ammunition box. The light within is a 110-volt 150-watt projection bulb used in any 2- by 2-inch slide projector and is available from any photographic equipment dealer. The lamp socket is a discarded automobile headlight socket and is secured to the side of the box with a strip of heavy-gauge iron sheeting. The condensing lens on the floor of the lamp box is an ordinary double-convex reading glass, 2 inches in diameter, its focal length 3½ inches. The stage for the projector is a sliding board with a movable fork to hold the standard microscope slides and is placed in slots of a holder below the light box.

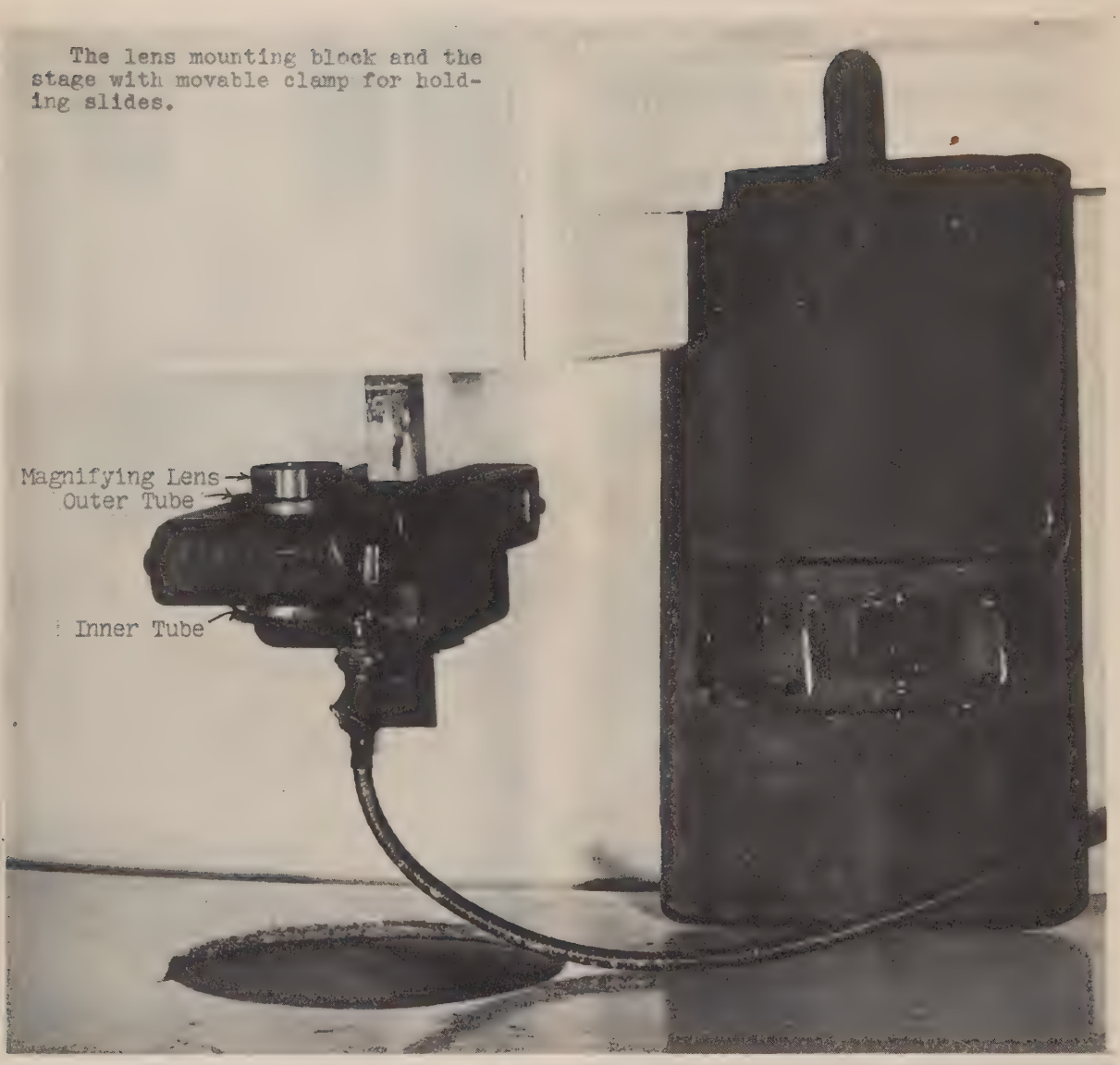
The magnifying lens consists of two small magnifying lenses 1 inch in diameter and secured in a tube 1¼ inches long. The focal length of this lens is 3/4 inch. The lens is secured in a block of wood attached to a sliding bar to make rough focusing adjustments whenever different slots in the stage-holder are used.

Final adjustment and sharp focusing are effected by means of a flexible cable. The magnifying-lens tube is placed in a section of pipe and held in place by a few layers of scotch tape. The outer surface of this section of pipe has been threaded from one end to the other. A light metal gear, 1-5/8 inches in diameter with a 1-1/8-inch hole in the center,



(Photos and drawing courtesy of author)

Over-all picture of microprojector and screen.



The lens mounting block and the stage with movable clamp for holding slides.

has been soldered to the lower end of the above-described tube. This tube has then been screwed into a larger piece of pipe secured in the block attached immediately below the light box.

The object placed on the stage between two microscope slides is projected toward the floor of the cabinet. An 18-inch circular mirror is mounted on the floor of the cabinet at the proper angle to reflect the image upward onto the lower surface of the screen. This screen is semitransparent, and the image is visible on the upper surface of the screen. The screen is made of a single sheet of mat-acetate placed between two pieces of 20-by 20-inch double-strength window glass. These two pieces of glass and the sheet of mat-acetate are held together by a strip of tape placed completely around the edge of the two sheets of glass. In addition to holding the glasses in place, the tape keeps dirt from getting inside the screen.

Maximum magnification with the present lens is 100 power. This magnification can be changed by raising the mirror on the floor of the box to shorten the projection length. Lenses similar to those used in this projector are available from almost any of the war-surplus lens dealers advertising in most of the photography

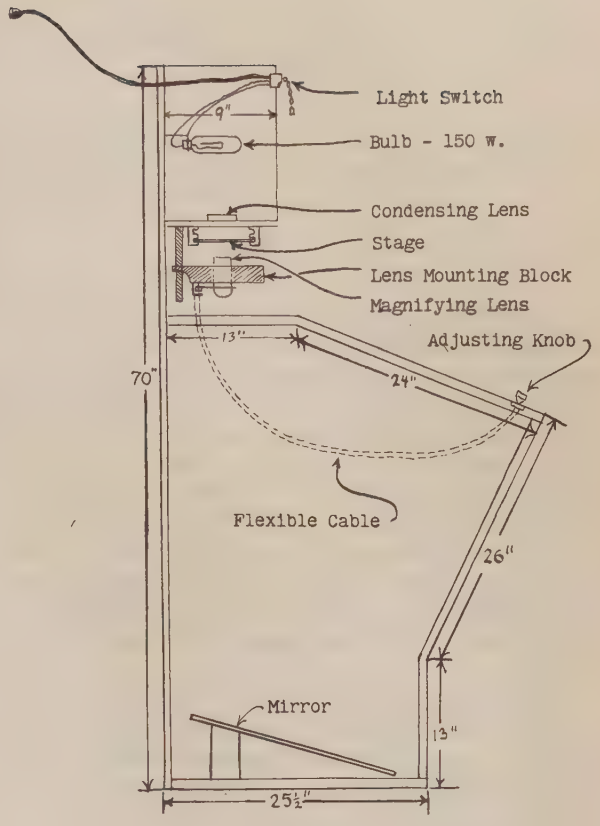
magazines.

A small bracket holding an 8-tooth gear has been attached to the lower surface of the block. This small gear is connected to a flexible cable and meshed with the larger gear on the lens tube. The flexible cable is an automobile speedometer cable. The adjustment knob placed on one end of the flexible cable is an automobile radio knob. This knob is held in place by a small bracket on the lower right corner of the screen. The turning of this knob revolves the cable and attached gear, which engages the larger gear and causes it to rotate. This rotation screws the inner tube into or out of the stationary tube and causes the lens to be raised or lowered for clear focusing.

This projector has been a great help to the Kentucky Game and Fish Division. The projector has been used principally in our stream-survey work, but it has also furnished valuable information for our farm-pond program.

Fish scales can be examined and measured much more rapidly on this machine than in a microscope. A large number of scales can be placed in a series of watch glasses filled with water. After soaking for 10 to 15 minutes, the scales are quickly cleaned with two soft-wood probes and mounted in a drop of water between two microscope slides that are hinged together with adhesive tape.

A description of the methods used in our scale studies can be obtained from Eschmeyer's paper, "Growth of Fishes in Norris Lake, Tennessee--1940," which appeared in Transactions of the Tennessee Academy of Science, 15 (3): 329-341.



FERTILIZER IN MALAYA AND SINGAPORE

The maker of a seaside fishpond in Malaya or Singapore usually just fences off a small arm of the sea, and he gets most of his fertilizer in the same area.

A pond having too heavy a growth of seaweed is drained, except for a small puddle from which the fish are seined. In the Malayan region, the seaweed is permitted to rot in the pond and then is spaded into the bottom. On the southern coast of China, the seaweed is hauled ashore and made into compost heaps before being returned to the pond. Along the Malaccan Straits, between Malaya and Sumatra, it is customary to feed tens of thousands of tiny fish (unfit for human consumption) to pigs and ducks--and then fertilize the fish-producing water with the refuse from these animals' pens.

THAT POTATO RICER AGAIN

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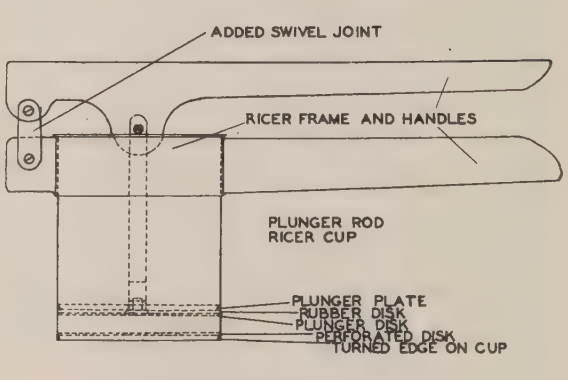
In the last few years, the modified potato ricer has become standard equipment in many of the hatcheries of this country. Because few of us who have used it have been entirely satisfied with its operation, however, many changes have been proposed to increase its efficiency. Mitchell (1941) suggested two major improvements, a cup without side holes and the inclusion of a gasket on the plunger; nevertheless, the gadget still had a few undesirable characteristics.

The addition of a swivel joint to the front connection of the handles (see figure) appears to eliminate one of the most-disliked features of the usual ricer. In the conventional type, especially if the ricer is nearly filled with food, the plunger does not remain parallel to the bottom or at right angles to the sides of the cup, and a considerable amount of food is forced back past the plunger. This makes it necessary either to fill the cup to only one-third of its capacity, or to work the food back down into the bottom of the cup two or three times in order to unload it completely. The added joint permits the plunger to be started parallel to the bottom and to be continued so all the way down; thus the full capacity can be used each time the ricer cup is filled.

Two other minor changes that were incorporated quite by accident have been of considerable advantage. These changes



came about because it seemed necessary to have a solid, one-piece, bottomless cup made by a professional tinsmith. First, the person contacted suggested the use of stainless steel, which has certainly proved its worth. Second, the cup as first made was about a quarter of an inch too deep for the plunger; so it was decided to remedy this by building up the turned edge of the bottom of the cup with solder until the perforated disk to be inserted could be brought flush with the plunger. The pocket thus formed on the bottom of the ricer permits the operator to put the ricer down in an upright position without smearing feed all over the landscape. Loading the ricer is now much simpler, and it is no longer necessary to scrub the hatchery after each feeding.

Still another minor idea that can be traced to Yankee thrift has been incorporated. As the original ricer cup was purchased with personal funds, it was decided to use one cup with interchangeable disks having perforations of various sizes. As these disks can be changed as the fish grow, the proper-sized food particles are given the fish.

See also:

Burrows, R. E., and Manning, J. E. 1947. Enlarged ricer for pond feeding. Prog. Fish-Cult. 9 (1): 42-45.

So that the disks will be held in place, they are slightly smaller than the inside of the cup, and the very small space between the disk and cup is just touched with solder. When it is desired to change disks, they can be knocked out easily by a sharp blow with a blunt instrument. Where funds are available, however, it might be just as well to have interchangeable cups with more permanent bottoms.

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CLEARING HOUSE

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